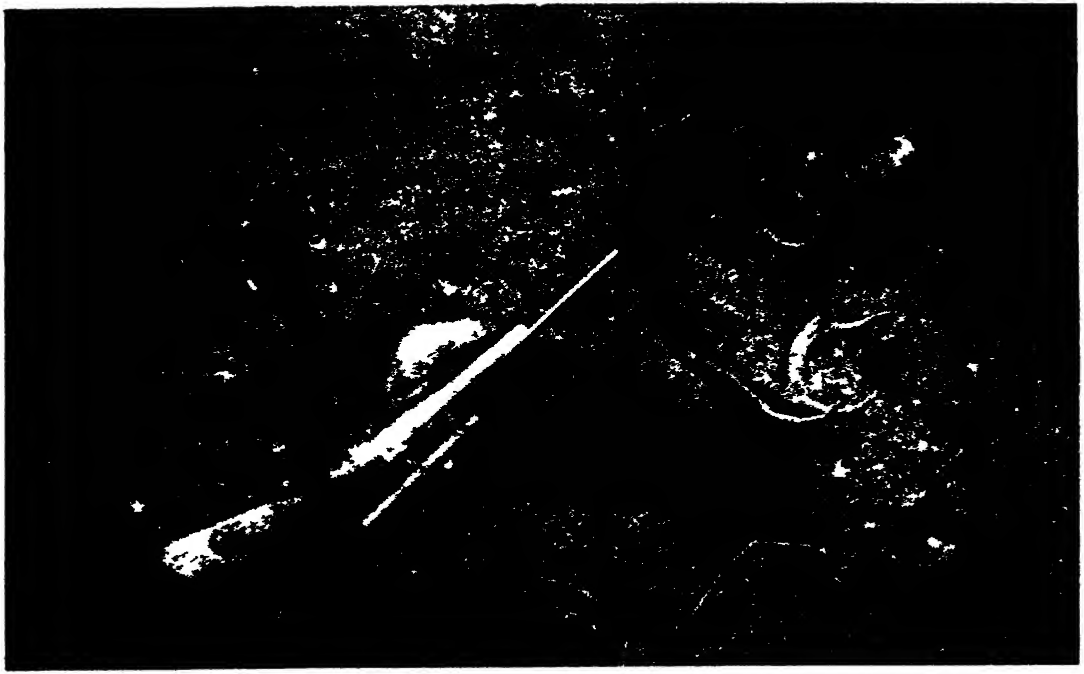
RIFLE AND GUN



By courtesy of Mr C Bailey

FALLOW STAG SHOT IN SCHLESWIG-HOLSTEIN.

RIFLE AND GUN
for Practice, Competition and Sport

BY

L. B. ESCRITT

[illegible]D CLAY AND COMPANY, [illegible]

TO MY WIFE

PREFACE

Firearms are interesting. That is a fact which cannot be gainsaid. Boys gaze entranced into gunmakers' windows, and middle-aged sportsmen treasure and meticulously care for small or large numbers of rifles and guns. For some shooters firearms are the means by which they can enjoy their favourite sport of game shooting or wildfowling: others use them in their endeavours to make smaller and smaller groups on targets at fixed ranges. But few can use rifle or gun without being interested in the weapons themselves. And again, there are those who collect antique or even recently made weapons for the sake of their value as examples of fine or ingenious craftsmanship.

The study of small arms and shooting embraces a very wide field, no section of which can be completely covered in one volume. Consequently a general book must deal with main facts and basic principles only, without going very deeply into any one aspect.

Many such general books have been published in America and have proved to be very popular. But the majority of recent British works have been devoted to game and game shooting, wildfowling, etc., the remaining few being highly specialised. Thus it happens at the present time that the young enthusiast, or any member of the public in search of general knowledge, is compelled to rely on encyclopædias, or go to the expense and trouble of obtaining literature from America.

The author has therefore set himself to produce a book similar in form to many of American origin, but yet different, in that the material is virtually restricted to shooting as practised in this country and to arms made by British gunmakers. In this endeavour, he believes that he will not only have supplied English shooters with something they have long been wanting, but will also have interested those readers overseas who are known to be anxious for information about the arms and ammunition which English gunmakers and manufacturers are able to supply. Should he have succeeded in doing either, his work will have been justified.

To ensure that the latest information on arms, ammunition and equipment is given, the illustrations reproduced in the text include photographs and engravings selected from the latest catalogues of, or from prints provided by, our manufacturers; and ammunition lists have been prepared and checked so that obsolete numbers are excluded. A few exceptions occur where old-time arms or weapons of pre-war pattern or foreign manufacture have been included, but in all such instances the fact is mentioned.

For the sake of the appearance of the plates it has been necessary, in making up composite illustrations, to assemble catalogue illustrations which were to the same scale. This has meant that rifles and guns of very different purchase price appear together.

L. B. Escritt

ACKNOWLEDGMENTS

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Acknowledgment is also given below the captions except where the source of the illustration is obvious.

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CHAPTER I

INTRODUCTORY

A GUN is an internal-combustion engine the purpose of which is to propel a shot or shots against an animal or enemy so as to inflict an effective wound. Guns can also be used against inanimate targets for practice or in competitions of skill.

The barrel of the gun is the cylinder of the engine, the shot the piston which receives the energy. The power is obtained from a charge of explosive mixture or compound which, on ignition, burns, producing hot gases and consequently pressure. The behaviour of the charge of powder and shot in the barrel of the gun is known as *interior ballistics*; study of the movement of the shot during its *trajectory* from the gun to the target is *exterior ballistics*.

Small arms are guns which can be carried and used by individuals. They are classified as *smooth-bore* or *shotguns* if the bore is smooth and intended to be used for shooting with spread shot; and *rifled arms* if the bore is rifled so as to accurately discharge a single bullet. Under the latter head fall rifles, carbines and pistols or hand-guns.

Gunpowder is the word now used for any explosive employed as a propellant in a gun. The first explosive used in guns was a mixture of potassium nitrate, charcoal and sulphur which is now known as *black powder*, to distinguish it from *nitro-powders*, which are various compounds of nitrogen or mixtures of such compounds. It was the discovery of gunpowder that led to the invention of the gun.

EARLY HISTORY

The origin of gunpowder is lost in obscurity, and the date when it was first used in a gun has not been definitely established. The date and circumstances in which portable firearms were introduced are also unknown. Gunpowder was introduced into England prior to 1346, for cannon were in action at the Battle of Crécy. The first small arms, "hand-gonnes"—small cannon fixed to a long staff which could be held with the butt against the

ground---were known in the fifteenth century, when the hand-culverin was introduced. This was a weapon of larger calibre, and was handled by two men, one of whom raised and aimed the piece, while the other applied the match.

Cannon which were loaded from the muzzle and fired by applying a match to the touch-hole were sufficiently satisfactory for use against fortresses or on board ship for this simple method of operation to be maintained until comparatively recent times. But the slow loading and uncertainty of firing just when aim was correct set the match-fired small arm at a disadvantage to the long-bow. An archer could release several arrows before a gun could be loaded, primed and fired, and his shots were more accurate than those of smooth-bore firearms. Thus these early guns owed more to their terrifying noise than to their practical effect.

A slight improvement was made when, towards the end of the fifteenth century, the match-lock, a mechanism which fired the piece on a trigger being pulled, was invented. The trigger was a long lever: it acted on a sear releasing the "serpentine", which was the forerunner of all hammers as used on flint-locks and, later, percussion guns. The serpentine, the shape of which was in conformity with its name, held a burning slow-match of tow, both ends of which were ignited, so that if one went out it could be relit from the other. On the trigger being pulled the burning match was plunged into the flash-pan, which was primed with fine powder, and from which the explosion reached the interior of the barrel *via* a touch-hole.

The wheel-lock, or fire-lock, was the first mechanism that made a hand- or shoulder-arm useful alike for war, personal defence or sport. It was originated between 1510 and 1520, when locks of this kind were made by the gunsmiths of Nuremberg and fitted to both hand- and shoulder-arms. Being elaborate, it was essentially part of the equipment of a gentleman rather than of the common soldier. It consisted of a serrated steel wheel which was rotated by a chain and powerful V-spring and which struck sparks from a piece of iron pyrites or flint. The lock had to be wound up before it could be fired.

The simpler "snaphaunce", a Dutch invention, which incorporated a flint-bearing hammer known as the "cock" arranged to fall on the "steel" to produce a spark and ignite the powder,

appears to have been introduced into England during the last quarter of the sixteenth century. It differed from later flint-locks in that the steel and the cover of the flash-pan were not made in one piece. The snaphaunce was followed by the true flint-lock, which had a combined steel and pan-cover so arranged that when the hammer fell on the steel it threw it forward, uncovering the pan and letting sparks fall on the priming powder.

Flint-locks were used for both sporting guns and rifles, until the outstanding invention of the first percussion-gun lock by the Reverend Alexander James Forsyth, M.A., in 1805.

The Percussion System

Forsyth was a wildfowler; and in his experience of shooting geese with the flint-lock he found that the time taken for the priming powder to explode and ignite the charge was sufficiently long to let the geese take alarm at the flash and fly away. His experiments were aimed at developing a priming powder that would explode more quickly, and with this in view he tried fulminate [illegible] and mercury and mixtures containing potassium chlorate. Th[illegible] explosives were too rapid to be used as ordinary primers, b[illegible]re not away before the charge was fired; but in the course of t[illegible]ridges, methods by which they could be used satisfactorily For[illegible] up in found that they could be exploded without the use of a flint [illegible]; and when confined, gave a sufficiently hot flame to fire a charge. [illegible]ridge

Forsyth's "detonating" lock had, in place of a flash-pan, [illegible] and small recess which contained a few grains of detonating powder which was exploded by a steel plunger driven forward by a hammer, resembling that of a modern side-lock gun. The flame passed from the bottom of this recess through a vent to the barrel, exploding the charge, and gases of the explosion were reasonably prevented from escaping through the vent by the plunger.

This detonating lock was much more certain and rapid in its action than the flint-lock, and though it was protected by a patent, many successful attempts were made to copy and improve on it. Joseph Manton invented and took out the first patent for a "pellet-lock", the hammer of which was bored to receive a pellet of cap composition which was detonated by a tubular striker. The hot gases escaped down the bore of this striker and through the vent of an "anvil", and so to the powder charge.

Much more successful than his pellet-lock was Manton's "tube-

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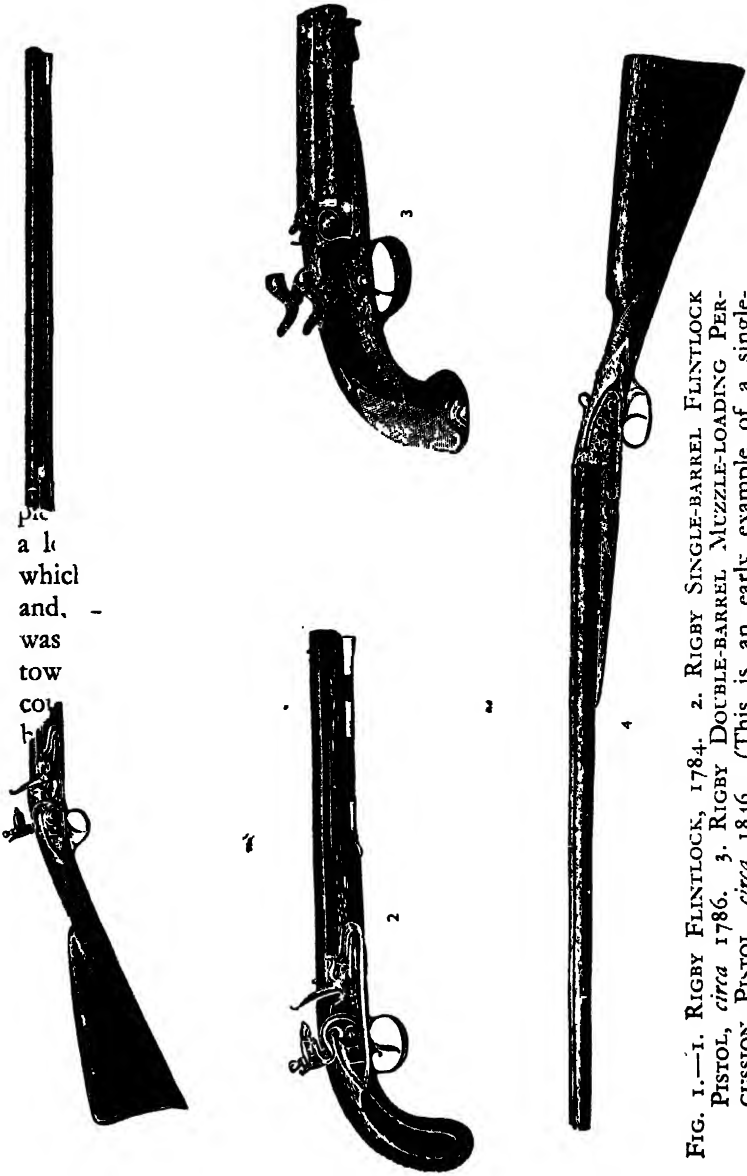


FIG. 1.—1. RIGBY FLINTLOCK, 1784. 2. RIGBY SINGLE-BARREL FLINTLOCK PISTOL, *circa* 1786. 3. RIGBY DOUBLE-BARREL MUZZLE-LOADING PERCUSSION PISTOL, *circa* 1846. (This is an early example of a single-trigger weapon.) 4. RIGBY "BEST GUN".

lock ". With this a thin copper tube filled with fulminate of mercury was used. One end of the tube was placed in the platinum-bushed vent of the gun, while the other rested on an anvil formed by part of the lock-plate, where it was held in position by a spring clip. The tube, which was about half an inch long and one-sixteenth inch internal diameter, was struck in the middle by the hammer, and exploded with violence straight into the vent.

The most marked improvement, the copper cap, which was shaped like a thimble and carried a small charge of fulminate at the crown, was invented before the expiration of the Forsyth patent. It was an instant success, because it could be used with flint-lock arms by simply providing them with nipples on which the copper caps could be fitted.

Breech-loading

The obvious advantages of breech-loading as a means of overcoming the slow process of loading from the muzzle led to many experiments, but the problems of *obturation*—*i.e.* prevention of escape of gas at the rear—and the overcoming of corrosion and jamming of the breech mechanism by powder residue were not satisfactorily solved until the invention of fixed-round cartridges, which contained shot, powder and cap composition made up in cartridge form so that they could be loaded in one operation; and until these had been developed in such a form that the cartridge case expanded on explosion to completely seal the breech and prevent gas escape.

Smooth-bore and Rifled Arms

The earliest shoulder- and hand-arms were smooth-bore weapons designed to fire single bullets for military purposes only, and this type of weapon persisted well into the nineteenth century: for the first army unit to receive the rifle was the 1st Battalion Rifle Brigade, who were equipped with rifles in 1839. Nevertheless, at an early date sporting weapons were developed and a distinction made between the rifle and the shotgun, for rifling was invented not later than 1520 and perhaps earlier; and the " fowling-piece " or " birding-piece ", an early name for the shotgun, is mentioned in Act IV, Scene II, of " The Merry Wives of Windsor ". It is possible that rifling was used long before its principles were understood, for it was not until 1747 that

Benjamin Robins showed that the virtue of rifling lay in its giving a spin to the bullet.

The English Gun Trade

About the time of the American Civil War, when in 1861 a record number of arms were exported, the English gun trade reached its height. The reputation for quality of the English " best " guns had already been established by many famous gunsmiths, including the Mantons and the founders of several firms still in existence. Since that time the English gun trade has declined in output, and where there were, in the nineteenth century, thousands of workers, now only hundreds are employed, and most of these are elderly men. Also one of the difficulties that the trade has recently experienced is due to the fact that a skilled gunsmith is always welcome and can command good wages in other engineering industries, and many who accepted war-time employment did not return to their original calling. This is being rectified by the recruitment and training of apprentices, but the shortage of highly skilled workmen is evident, if only in the difficulty that can be experienced in getting minor repairs done in a reasonable number of months, or satisfactorily executed. This is a matter which the gun trade ought to look into, in its own interests.

Although the prosperity of the trade has undoubtedly declined, there has been no falling off in the traditions and standards of manufacture. For English gunmakers are now justly renowned for their superb craftsmanship and the quality of their work generally. A very great part of English gunsmithing is the manufacture of exceedingly high-quality arms, and some of the leading firms now make " best " guns only.

The English gun and double rifle is beyond question without equal, and the products of the leading English firms are sold throughout the world to professional and amateur hunters who will have the best. John Taylor, whose practical experience of the use of many kinds of high-quality rifles in big game hunting is exceptional, expresses, in *Big Game and Big Game Rifles*, the following opinions :

> " You will do better, far, far, better, to buy one good British-built rifle than a battery of cheap, Continental weapons at the same price. The tremendous confidence which is yours

when you know that there is not the slightest fear or danger of your rifles or ammunition letting you down is of incalculable benefit. Be they doubles or magazines, it matters not: Have your rifles built by one of the best London gunsmiths; get your ammunition through them; and you will find that your shooting and your pleasure in shooting will improve out of all recognition.

"I am firmly and absolutely convinced that, at the very least, 50 per cent. of what success I have had is directly due to that feeling of confidence engendered by only using the best rifles and ammunition. Since I first started using best-quality London-built rifles and ammunition, many years ago, I have used nothing else; and I can honestly and truthfully state that I have not had a single, solitary jam, misfire, hang-fire, or weak round from that day to this."

The Americans are admittedly ahead of us in many respects. In the United States amateur enthusiasts and experiment have led to great advances in cartridge design: more numerous and varied patterns of telescopic sight are available than here: and mass production of sound arms at reasonable price has for long been highly developed. But the work of British gunsmiths is unequalled in the perfection of finish. Townsend Whelen, the well-known American authority, makes this admission in *The Hunting Rifle*:

"Our arms manufacturers have always been behind in the interior finish of their locks and breech actions. This is most noticeable in shotguns, but applies equally well to rifles. If the reader will take the trouble to dismount the locks of very expensive American double shotguns, and similarly examine the locks of the best British makers on weapons of equal price he will be amazed by the difference. The polish and fit of the parts of the British locks are superb, every portion polished like a mirror, the fit exact, and the action velvet smooth, while the American locks look as though they had just come from the forge, black, with no finish whatever."

Francois Sommer in his book *Man and Beast in Africa* comments highly and at length on the integrity of the leading British gunmakers and the quality of their products which, as he says, are always exceptionally well finished, adjusted and tested. He goes

on to say that after considerable experience of magazine rifles, he reached the conclusion that only those of British manufacture could be relied upon as trouble-free, and added also that he considered the leading British gunmakers to be about the only makers able to produce really satisfactory big double rifles of unfailing reliability.

Amateur Rifleman and Gunner

Firearms have a technical interest of their own, apart from their uses, and in America amateur gunsmithing, hand-loading of ammunition and the collection of antique arms have a large following which has no counterpart in Great Britain. For in America the amateur rifleman can obtain cartridge cases, caps, powders of standardised blends, bullets, etc., quite easily from a variety of firms; consequently reloading and resizing tools and bullet-moulds are manufactured and marketed for his use. The American rifleman also has wide spaces and numerous shooting-ranges at his disposal.

As a contrast, enthusiasts in Great Britain have the utmost difficulty in doing any experimenting; and because powders and primers, bullets, etc., are very difficult to obtain, no firm has found it an economic proposition to make reloading tools.* The English "gun cranks" also do not always find it easy to obtain firearms certificates for all the weapons they would like to use, and ranges other than those suitable for small-bore shooting are few and far between.

There are, however, English rifle enthusiasts who tend to develop into amateur gunsmiths, altering and improving their weapons to their own satisfaction by restocking or making minor changes to the mechanism. And users of the shotgun go to considerable expense, having first quality weapons built to measure and to their exact requirements.

The present-day uses of rifle and gun by the amateur shooter are for practice at the rifle club, competition at club or open meetings, clay-bird shooting, organised shooting at game, rough shooting, vermin-shooting, stalking and wildfowling.

The following pages are therefore devoted to small arms from the point of view of their uses for practice, competition and sport, and of their technical interest.

* Except for shotgun cartridges.

CHAPTER II

BALLISTICS

NEARLY all weapons—swords, spears, guns, etc.—are designed to cause injury by bringing to bear on the tissues of an animal or enemy a greater pressure than can be withstood. Injury can be caused with a blunt instrument applied with great force, but much less effort need be expended when the weapon has a sharp point or edge that concentrates the applied force over a small surface.

A weapon would injure the *user* if the part held in the hand (or against the shoulder) were as sharp as that brought to bear on the target and the pressure between it and the surface of his body were equal to the pressure inflicted on his enemy. But this is never the case, for a hand-weapon such as a sword or spear is sharp at the point or cutting edge and has a large comfortable surface where it is gripped.

Moreover, with many weapons it is customary to *strike a blow* the force of which is picked up over a period of time during which the weapon is swung in the hand, but expended instantly on the target. When a stone is thrown it does not hurt the hand of the thrower, but it does hurt the man it is thrown at. In like manner a gun is made to drive a more or less sharp-pointed bullet with great force so as to penetrate, while the butt of the gun held against the shoulder of the shooter, although it is driven back with greater momentum than that of the bullet, bears over a larger surface and, moving with a lower velocity than the bullet, carries less energy. The bullet is driven forward throughout its motion through the barrel of the gun by continuously applied pressure, which at no time is greater than the barrel can withstand, although the same barrel struck by a high-velocity bullet might be penetrated from side to side.

Firearms are designed for specific purposes, elephant guns being heavy and of large calibre, but not necessarily of long range or particular accuracy. Military rifles are of small calibre, shoot accurately at long range and, because they have to be carried as part only of the heavy equipment of the soldier are made as light as possible. It will therefore be seen that firearms are a com-

promise between effectiveness and weight. And in order that they shall be as effective as practicable without the weight of the gun being excessive and the ammunition unduly costly, ammunition and gun are designed in detail so that the charge of powder and shot will inflict the most effective wound possible with the materials used.

Wounds

To be effective a wound must be as large as the force applied permits. Energy must not be wasted. A small bullet will often pass right through a soft-skinned animal without stopping it, and soft bullets "splash out" on the surface of a thick-skinned animal, such as a rhinoceros, causing a nasty, but not fatal, superficial wound. The ideal condition is that in which the bullet passes nearly, but not right through, the animal, and in so doing expands enough to make a large hole without breaking up.

Consequently, charges of powder are varied according to the velocity required and the weight of bullet that they have to impel. Bullets differ in calibre, weight, shape and design, some being made to penetrate, others to expand.

Apart from the proper proportioning of the size of bullet and design so as to expand just the right amount, the destructive power of the blow which it inflicts is in direct proportion to its kinetic energy derived from the energy of the powder. Energy is measured in foot-pounds, a foot-pound being the amount of energy required to lift 1 lb. weight against gravity a vertical distance of 1 foot. The ·22 long rifle "Rifle Club" cartridge, which delivers a blow of about 100 foot-pounds at moderate range, hits the target with the same energy as a 50-lb. weight falling 2 feet, or a 10-lb. weight falling 10 feet. Manufacturers give the powers of rifles (or, more correctly, of the ammunition they are made to be used with) in foot-pounds in order that the purchaser may know for what purposes they are suitable.

Hydraulic Shock

The damage done by a bullet to a living organism is more than the piercing of a hole. A bullet strikes on to fluid-filled material (as is most animal tissue) with such force that it causes the material to burst in all directions. This is particularly the case with very high-velocity bullets (more than twice the speed of sound), which cause damage by shock over a large region surrounding the wound.

The effect of hydraulic shock can easily be demonstrated by putting an ordinary ·22 bullet through a juicy fruit or potato, which will burst in all directions, or through a tin can filled with water, which will be bulged or will burst at the seams. There is no hydraulic shock or bursting effect when a bullet is fired through dry material such as a withered potato.

Fig. 2 shows a beer can which had been filled with water and shot at with a ·22 Long Rifle hollow-point Super Speed Winchester

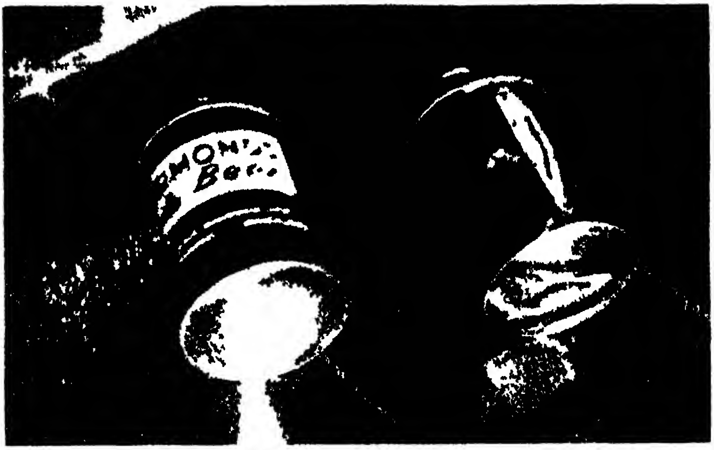


FIG. 2. BEER CAN HIT BY BULLET.

The beer can on the right has been hit by a bullet from a ·22 Long Rifle cartridge. Hydraulic shock has caused the can to split at the seam and to bulge at the bottom. On the left is an undamaged can for comparison. A can struck by a bullet from a ·22 Hornet cartridge was blown to pieces.

cartridge. The bottom of the can is buckled and the soldered seam at the side split. An undamaged can is shown for comparison. A water-filled can shot at with the ·22 Hornet just disappeared: two pieces of tin were found nearby.

Owing to the shock effect of high-velocity bullets, it is possible to use a small calibre magnum rifle with a high-velocity cartridge in place of a larger-calibre rifle and low-velocity cartridge. Theoretically the wounding effect of a bullet varies in proportion with the bullet's kinetic energy, and (as will be shown) a considerable reduction of bullet-weight can be counterbalanced by a moderate increase of velocity. There is, however, disagreement on the extent to which high-velocity rifles can replace

those of large calibre, for several big-game hunters have found by practical experience that a large-calibre bullet has a more certain knock-out effect on big game than a small high-velocity bullet of the same energy.

Mass and Energy

Energy is of two kinds: potential and kinetic. Potential energy is the ability of a body to do work by virtue of its mass and the distance through which it can fall, and is measured in terms of mass, m, and distance, s, the energy of the body being ms.

Kinetic energy is the energy of a body by virtue of its mass and velocity.

When a body falls, its potential energy is converted to kinetic energy, and similarly if a force is applied to a body giving it motion, it absorbs energy in proportion to the force and the time over which it is applied.

If a force is applied to a body already in motion with a velocity u, it moves with a constant acceleration f in its direction of motion, and if v be its velocity at the end of time t, and s the distance from its starting point at that instant, then:

$$v = u + ft \qquad (1)$$
$$s = ut + \tfrac{1}{2}ft^2 \qquad (2)$$
$$v^2 = u^2 + 2fs \qquad (3)$$

When a body falls under gravity, the rate of acceleration is, as has been found by experiment, about 32·2 feet per second for every second it is falling. This value varies slightly with latitude. United States writers assume a value of 32·16, which is about the average for the States. 32·2 is assumed in Great Britain. Then:

$$v = u + gt \qquad (4)$$
$$s = ut + \tfrac{1}{2}gt^2 \qquad (5)$$
$$v^2 = u^2 + 2gs \qquad (6)$$

where:

v = velocity in feet per second at end of time t
u = initial velocity in feet per second
g = 32·2
t = time of falling in seconds
s = distance traversed in feet

If the body starts from rest, $u = 0$. Then:

$$v = gt \quad \quad (7)$$

$$s = \tfrac{1}{2}gt^2 \quad \quad (8)$$

$$v^2 = 2gs \quad \quad (9)$$

From the above it will be seen that if a body is permitted to fall through a distance s it converts its potential energy into kinetic energy, which is expressed in terms of mass and velocity and can be calculated from formula (9). The energy ms then becomes converted to $\frac{mv^2}{2g}$, from which it will be seen that the energy of a bullet varies with its mass and the *square* of its velocity.

The following is an example calculation. Referring to Table 2, at the head of the first column are given the bullet weight in grains, the muzzle velocity in feet per second, and the muzzle energy in foot-pounds. The last figure is calculated from the others according to the formula:

$$\text{energy} = \frac{mv^2}{2g}$$

allowance being made for the fact that there are 7,000 grains in 1 lb. Then:

$$\text{energy} = \frac{40}{7000} \times \frac{1400^2}{2 \times 32{\cdot}2}$$
$$= 174 \text{ foot-pounds.}$$

(The foot-pound is the unit of energy most commonly used by engineers, and is approximately 32·2 foot-poundals, the foot-poundal being the British absolute unit of work.)

Interior Ballistics

The acceleration of a bullet in a gun is not constant. At first the pressure of the explosion builds up sufficiently to push the bullet out of the cartridge and into the barrel, and as the pressure continues to increase, the rate of acceleration of the bullet increases likewise: but as the powder burns away, the rate at which the gases are produced falls off, while at the same time the bullet moving up the barrel leaves behind it more space for the occupation of the gases, thereby reducing the pressure.

The rate of acceleration then reduces until, if the barrel is long enough, there comes a time when the pressure of the gases is less than sufficient to overcome the friction between the bullet and the barrel, so that the speed of the bullet falls off before the muzzle is reached. In most rifles this falling off of velocity does not occur, acceleration continuing until the bullet has left the barrel; but, according to Townsend Whelen, the maximum velocity in a rifle firing the ·22 Long Rifle cartridge occurs when the bullet has arrived at a distance of 16 to 20 inches from the breech; any extra barrel length above this distance serves only to increase the friction and reduce velocity.

A quick-burning powder produces a very high initial pressure, and therefore initial acceleration. But if the pressure is not sustained, the muzzle velocity may not be so high as that produced by a slower-burning powder which produces a lower initial pressure but sustains a moderately high pressure throughout the passage of the bullet through the barrel. A high pressure calls for a strong barrel, and as strength means weight, which may be undesirable, there is, in some instances, much to be said for the use of slow-burning or *progressive* powder.

Pressure Barrel

The pressure produced by firing a cartridge can be measured with a *pressure barrel,* which is a gun or rifle barrel of very great strength. A hole is bored through this barrel at right angles to the bore at the point or points at which pressure is desired to be known, and in this hole a piston is fitted so as to be gas-tight when lubricated, but free to move. The inner end of this piston is flush with the bore; the outer is finished flat, and against it is placed a *crusher,* which is a small cylinder of lead (in the case of guns) or copper (in the case of rifle ammunition producing high pressures). To hold the crusher in position and take up slack, a screw working through a fixed stirrup is brought up against it.

When the gun is fired, the piston moves and compresses the crusher by an amount which depends on the pressure developed in the barrel. By measuring the new length of the crusher after it has been compressed as compared with the original length, and referring to a table, the pressure developed in the bore may be found.

In testing shotgun cartridges in a pressure gun, one piston is

placed 1 inch from the breech, where the maximum pressure normally occurs, and another at 6 inches from the breech, to ascertain if the pressure is maintained. The cartridge case is bored in the appropriate positions to give gas access to the first piston. A normal maximum pressure for a $2\frac{1}{2}$-inch twelve-bore cartridge is $2\frac{1}{2}$ to 3 tons (British) per square inch. Anything more is excessive, and pressure exceeding 4 tons is dangerous.

Rifle pressures are much greater than shotgun pressures, the small ·22 cartridge producing a normal chamber pressure between 6 and 7 tons per square inch. The methods of recording rifle pressures are similar to those used for shotguns, except that crushers are of copper instead of lead, and greater care has to be taken to prevent leakage of gas. The maximum pressure is recorded an inch from the breech, except where low-power ammunition is concerned. A distance of $\frac{3}{8}$ inch is usual for pistols. In addition to the measuring of pressure at points on the bore, pressure can also be recorded by a crusher arranged in the bolt of the pressure gun behind the cap of the cartridge.

The *Field pendulum pressure gun*, used for testing cartridges, is a heavy barrel gun having a total weight of 50 lb. This is suspended by two pairs of wires so that it can recoil backwards on being fired by a release similar to the bulb or cable release of a camera. The weight being known, the velocity of recoil can be calculated from the distance the gun swings back, by chronograph or other means. Chronograph circuits are used in front of the gun to measure the velocity of the shot over 20 yards.

Recoil

One of Newton's laws is that action and reaction are equal and opposite. Applied to ballistics, this means that the sum of the momenta of a bullet and the powder gases and residue that travel with it is equal to, but in opposite direction to, the momentum of the gun. The heavier the bullet and powder charge, the heavier the blow which the butt of the gun strikes against the shoulder of the shooter. But as the energies of the bullet and of the gun depend on the square of their respective velocities, the gun carries much less energy than the bullet, otherwise it would injure the shooter.

For example, if a charge of shot weighs $\frac{1}{16}$ lb. and the gun which fires it $6\frac{1}{4}$ lb., and the velocity of the shot is 1,000 feet per

second, the backward velocity of the gun (neglecting the weight of the powder) will be 10 feet per second. Then:

$$\text{energy of shot} = \frac{1}{16} \times \frac{1000^2}{2 \times 32\cdot2} = 970 \text{ foot-pounds}$$

$$\text{energy of gun} = 6\tfrac{1}{4} \times \frac{10^2}{2 \times 32\cdot2} = 9\cdot7 \text{ foot-pounds.}$$

The energy of the charge of shot is sufficient to kill a large animal; that of the gun amounts to a quite moderate recoil.

The amount of recoil that can be tolerated depends on the number of shots fired during a day or in a short time. The recoil energy of an elephant rifle is 50 or more foot-pounds, which is a heavy kick; but several shots in succession from an elephant rifle are rare. The maximum energy of recoil considered advis-

FIG. 3.—SIGHT-LI

The bullet rises from below the sight line to above and falls below again. By adjusting intermediate ranges and some distance beyond with a permissible degree of error above and

able for a military rifle is 15 foot-pounds. That of the S.M.L.E. rifle used with the Mark VII cartridge is 11 foot-lb., and is therefore very moderate. An ordinary twelve-bore shotgun has about twice the recoil energy of the S.M.L.E.

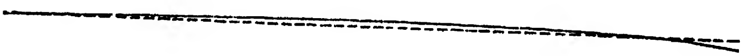
Another factor to be taken into account is the weight of the shoulder of the shooter. If the gun is held firmly to the shoulder, the shoulder goes back with the recoil, reducing its velocity. Consequently a big man can tolerate a heavy recoil unless he does not bring his gun properly to the shoulder, in which case he receives a violent blow.

In practical ballistics the weight of the powder charge cannot be neglected, for recoil is made up of three components: reaction of the bullet or shot charge, of the gases that follow the bullet to the muzzle, and of the powder gases that escape at the muzzle. Before the bullet actually leaves the gun the velocity of the gases in the barrel is approximately one-half that of the bullet, because the gases are expanding, and while the foremost particles follow the bullet at its velocity, the hindmost remain virtually motionless

at the breech. But when the bullet has left the gun, the gases then rush out at a high velocity.

Muzzle-brakes

An appreciable proportion of the recoil of a rifle is due to the reaction of the gases which, escaping in the direction of the bullet, jet-propel the rifle backwards, and therefore if these gases can be deflected laterally, recoil is reduced. *Muzzle-brakes*, which are used with automatic military weapons, consist of slots or perforations in a tube carried beyond the barrel of the weapon. These are so designed that expansion of the gases takes place in the muzzle-brake or recoil reducer, and so a good deal of the gas escapes sideways instead of forwards, impinging on the structure of the muzzle-brake, pulling the barrel forward against the recoil.



.AND TRAJECTORY.

e sights so that trajectory and sight line coincide at a suitable range, the rifle can be used at al ow.

Slots of perforations made on one side of the extension of the barrel are used also for the purpose of counteracting the tendency of the muzzle to climb during a burst of automatic fire.

Exterior Ballistics

Newton's first law of motion is that a body in motion and not acted upon by an external force continues in a straight line and at a uniform velocity. This is a fact which is seldom observed, because in everyday experience bodies in motion are always acted upon by external forces. A stone thrown into the air does not continue in a straight line, because it is pulled to earth by the force of gravity and retarded by the friction of the air. Under these forces it follows a curve known as its *trajectory*.

If a bullet were to be pushed gently out of the barrel of a gun it would fall to earth according to the formula:

$$s = \tfrac{1}{2}gt^2$$

the distance of the fall varying as the square of the time taken. If it were to be fired out of the gun horizontally at a high velocity, it

would still fall to earth the same distance in the same time; but, owing to its higher horizontal velocity, instead of reaching the ground just in front of the muzzle of the gun, it would land at a considerable distance away.

If the muzzle of a gun were pointed at an angle upwards, the velocity of the bullet could be divided into two components, vertical and horizontal, the first of which would act against the force of gravity, delaying its fall to earth, the second of which would carry it away from the gun in a horizontal direction; and if the gun were fired in a vacuum so that the resistance of the air could not retard the bullet, it would be found that the longest range in dead flat country would be achieved when the gun was pointed at an angle of 45° to the horizontal. In practice, the resistance of the air makes the longest range of a service rifle possible when the rifle is held at an angle of about 30° to the horizontal.

Trajectory

It is not necessary to enter here into details of the mathematics of trajectory, because the forces which act upon a projectile, and which determine its course, are not fully known, or the means by which they can be calculated completely solved. These matters concern the artilleryman, who calculates where his shells will go; but the average rifle-shooter is not greatly interested, for he always works by experience and trial and error—the only practical approaches open to him. The main fact which concerns him is that he has to allow more elevation for long range than for short, and that the higher the velocity of the bullet used, the less the allowance he has to make. In target-shooting, elevation is corrected by fine adjustment of micrometer or vernier sights. Cruder sight adjustment is available on military rifles. Sporting rifles are provided with sights adjustable in stages, or without adjustment at all, the shooter having to aim over or under, according to whether the range is more or less than that for which the fixed sights are set.

At target shooting ranges are accurately known, but in the field they have to be estimated, and if the distance is wrongly guessed the shot will arrive above or below the point of aim. The amount of error is reduced if the bullet velocity is high, and this is why high-velocity ammunition is used for military pur-

poses, and is advantageous to the sportsman when shooting at small game or over long distances.

Trajectory and Line of Sight

There are two distances from the muzzle at which the line of sight coincides with the bullet's trajectory. A bullet travelling in the direction of the bore of the rifle starts a good fraction of an inch, or sometimes more than an inch, below the line of sight, crosses the line of sight, rises above it, falls back to the line of sight at the range for which the sights are adjusted, and then falls (see Fig. 3).

If the range for which the sights are adjusted is not too great, if the velocity is sufficiently high for the trajectory of the bullet to be not too curved, the maximum rise of the bullet above the line of aim may be so little that at all distances between the muzzle and the range for which the sights are adjusted the bullet will hit sufficiently near to the point of aim for practical purposes. Also, for some distance beyond the point of aim the bullet will not fall too low to be effective.

Thus, the sights of a sporting rifle can be adjusted to an optimum range, determined according to the capabilities of the rifle and the size of the vital area of the game for which it is to be used. For example, if the ·22 standard Long Rifle cartridge is used and the sights adjusted for 60 yards, the foresight being about $\frac{3}{4}$ inch above the centre of the muzzle, the bullet will not rise more than 1 inch above, or fall more than 1 inch below, the line of aim in a distance of 70 yards; if high-speed cartridges are used and the sights adjusted for 75 yards, the error of aim will not be more than 1 inch up to a distance of 85 yards.

Similarly, if a rifle chambered for the ·22 Hornet is sighted to hit the mark at 150 yards, the bullet will rise about an inch above the line of aim at 100 yards, and at 175 yards it will not have dropped as much as an inch below the line of aim.

A sportsman can make allowance for slight variations of this kind. Having sighted his rifle to the optimum range, he knows that he can hit the mark at all intermediate ranges and for a moderate distance beyond. If he has to shoot still farther, he can hold over. Alternatively, if he desires to use his rifle at comparatively long ranges, he can sight it accordingly and hold under at intermediate distances.

CHAPTER III

ACCURACY

THE rifle has the quality, not shared by any other arm, of extreme accuracy. And not only is it mechanically accurate, but an expert can avail himself of its accuracy very nearly to the full. Great skill may be attained in the hand-thrown missile or with the bow and arrow; but with no weapon other than a rifle can a circle of 2 inches diameter be hit ten times in succession at 100 yards range by the most skilful contestant.

Nevertheless no rifle is absolutely accurate, placing all its shots on the same spot when consistently held to one aim. If a rifle is placed in a mechanical rest, which eliminates all human error, and a number of shots fired, they form a *group* of which the overall size is the measure of the rifle's accuracy with the ammunition used. The degree of error as expressed by the diameter of the group is partly due to the ammunition—for cartridges cannot be made exactly alike in every respect—and partly due to the rifle. The position of the group relative to the point of aim is merely a matter of sight adjustment and is capable of correction.

When a rifle is held in the hands it produces a larger group than that made when it is in a mechanical rest, the size of the group then depending on the skill of the shooter as well as the accuracy of the rifle: in competition the combined errors of rifle and rifleman determine the score.

The average sporting rifle, which, broadly speaking, can be considered less accurate than a target rifle, is more accurate than necessary, for sporting shots are seldom taken from the steady prone position or at long ranges. A sportsman tries to get into a position or at a range at which he can secure a certain kill with the first shot. On the other hand, a target rifle is made as accurate as possible because, as its small errors add to the errors of the shooter, they, in the long run, reduce his " average ".

One could say that there are two kinds of inaccuracy: gross inaccuracy and slight inaccuracy. An example of the former is the inaccuracy of an unrifled musket, the bullet of which rattles from side to side of the barrel and leaves the muzzle at an un-

predictable angle. A rifle, being an accurate weapon, does not suffer from gross inaccuracy unless it is faulty or is used with faulty ammunition. The study of rifle accuracy is therefore confined to finding the causes of the small deviations of the track of each bullet from that of the average of a representative group.

Effect of Rifling

There are forces other than gravity, air resistance and wind which act on a bullet, tending to deflect it from its straight course, some of which are due to the form and motion of the bullet itself.

If a single bullet is fired out of a smooth-bore gun such as an old-time musket or a true cylinder shotgun, it does not take a straight course in the direction of aim, but may hit anywhere within a circle of about 40 inches diameter at 100 yards! It was for this reason that muskets were comparatively ineffective weapons except at close range.

The principal cause of this gross inaccuracy is that the bullet is never perfectly symmetrical and, as a consequence of air resistance being greater on one side than another, it follows a curved and irregular course. If the bullet can be made to spin about an axis in the direction of its motion, this irregularity is largely balanced out, for, instead of curving away from the target, it adopts a spiral course which is imperceptibly different from a straight line, apart, of course, from other causes of deflection, such as the action of gravity and the wind.

A second advantage of rifling is that if a bullet can be made to travel in the direction of its longest dimension, it is much less impeded by the air, and therefore maintains its velocity and striking power for a longer time and travels a greater distance. In other words, its effective range is increased.

The twist of the rifling has to be designed according to the ammunition. A slow-travelling bullet needs a sharper pitch of rifling to give it the same speed of rotation as a high-velocity bullet; a long bullet needs a faster spin to keep it stable than a short, fat bullet.

There is a limit to the amount of twist that can be applied, for if the twist is too great, the bullet will strip—*i.e.* pass through the barrel without rotating, leaving torn-off metal in the grooves.

Yaw and Drift

If you spin a top, it may begin by wobbling a little, then " go to sleep ", until finally it wobbles a bit before falling over, when its speed has become insufficient to keep it steady. This wobbling known as *precession* in the case of tops and gyroscopes, but referred to as the *yaw* of a bullet, causes bullets to follow a spiral course in the air, and this is one of the main reasons for such inaccuracy as remains in the most accurate of rifles. Under the influence of the air-stream, a bullet tends to steady up after travelling a considerable distance. This yaw is particularly noticeable in boat-tail bullets, which usually travel a good distance before settling down into steady flight.

If a bullet were fired in a vacuum it would continue to point in the direction in which it pointed when it left the muzzle of the rifle. But in practice the resistance of the air makes it follow its nose and come down nose first. There is only one exception: if a bullet is fired vertically upwards it continues to point upwards, and eventually falls on its base.

In turning the nose of a bullet in the direction of travel, the air sets up forces which cause the bullet to turn slightly in a horizontal direction towards the direction of spin. This, aided perhaps by the difference of friction between the rarer and denser air above and below the bullet, makes it move laterally in the direction of spin by a small amount. This is known as *drift.* English military rifles are given a left-hand twist in order that drift shall be to the left, tending to counterbalance at long ranges the effect of the rotation of the earth, which, in the northern hemisphere, tends to cause an error to the right. Most other rifles made in this country and abroad have right-hand twists, for no particular reason. The left-hand twist has an additional advantage in a high-power rifle—it makes the butt move away from the cheek, not jar against it, and thereby renders the recoil less noticeable.

Causes of Slight Inaccuracy

One of the causes of slight inaccuracy is imperfection of the bullet, which may in some instances be due to imperfection of the chamber of the rifle.

When a cartridge is fired the pressure of the gases expands the

case so as to make it completely fill the chamber and release its grip on the bullet. At first the gases escape through the annular space between the throat of the case and the bullet and past the bullet into the barrel. But as the pressure increases, and the bullet, which is now in motion, receives a check on entering the leed, the back of the bullet is set up by the pressure so as to completely fill the barrel to the bottom of the grooves. The exact size of the bullet is important from the point of view of accuracy, for when the bullet begins to move it tends to wobble into the leed, and its base may become deformed by the pressure, so that the centre of gravity does not coincide with the centre of form. This has the effect of making the bullet fly off at the muzzle out of line with the direct line of the barrel.

This throwing off at an angle at the muzzle also adds to the precession of the bullet, which consequently takes a spiral course towards the target. The two errors due to the initial angle of the line of flight with the line of the bore and the spiral flight may either cancel one another out in greater or lesser degree, or be added together, so that the bullet may arrive on the target anywhere within the circle which circumscribes the group of which that particular rifle and ammunition are capable.

Imperfections of Bore and Muzzle

Imperfections of the bore, rust pitting, or heavy leading cause inaccuracies. It is also often stated that a bellmouthed muzzle has the same effect, but F. W. Mann found by experiment that:

> " A very serious mutilation does not throw the bullet from the line of bore of rifle to any greater degree than nearly all first-class barrels . . ."
>
> " A pretty serious permanent mutilation in bore at muzzle simply furnishes a new barrel to be sighted up before fit for target practice."

Colonel Townsend Whelen, in Vol. 2 of " Small Arms Design and Ballistics ", made an experiment in which " the rifle shot each lot of ammunition more accurately with the deformed muzzle than with the perfect muzzle ", although he states " this is believed to be merely an incident ".

Bellmouthing can be cured by cutting about ½ inch off the end

of the rifle, or, better still, by counterboring to a diameter of about $\frac{1}{8}$ inch larger than the bore of the rifle for a similar distance. After cutting or boring, the burr should be taken off. This is best done with a ball-shaped or hemispherical stone, which is spun in a breast drill, the axis of which is rotated slightly at the same time. The effect of this is to give the muzzle a smooth, burr-less finish that is truly at right angles to the axis of the bore.

Mean Radius of Group

The mean radius of a group of bullet-holes in a target is found as follows. First, a vertical line is drawn to one side of the group and the average distance from this line to the centres of the bullet-holes is found. Another vertical line is drawn at this distance from the first and the centre of the group will lie on this line. Similarly a horizontal line is drawn from which the average distance is again found. A second horizontal line is drawn at the correct distance with the centre of the group again lying on it. The intersection of the two lines gives the centre of the group. From this centre the distances of the centres of the bullet-holes are measured and averaged to give the mean radius.

Barrel Flip

When a rifle barrel is struck it gives a more or less ringing sound, consisting of a fundamental vibration and various overtones, showing that it bends throughout its length or vibrates between a number of nodes. Similarly, when a rifle is fired the barrel bends under the shock of the explosion, and at the moment when the bullet leaves the muzzle the end of the barrel is not in a straight line with the general line of the bore, so that the bullet is thrown above or below or, usually to a lesser extent, to one side of the line of the bore. This is known as *barrel flip*.

Barrel flip varies according to the charge of the shot. For example, most of the writer's small-bore rifles shoot lower with high-velocity ·22 ammunition than when used with the standard cartridge, although a B.S.A. 12/15 which has had 8 inches cut off the end of the barrel shows very little difference. Thus it is possible to make some adjustment to the barrel of a rifle which is intended to be used with more than one kind of cartridge without sight adjustment.

Barrel Bedding

The bedding of the fore-end affects accuracy. If the fore-end is not properly bedded, and touches the barrel at some points intermittently, shooting becomes erratic. If it is firmly fixed to the barrel at more than one point and warps, it may bend the barrel and alter the zero of the rifle.

Perfect bedding is perhaps the best for accuracy, but it is expensive, and not practicable for mass-produced rifles. Other forms of bedding are two-point, floating and semi-floating. In the two-point system the fore-end is fixed to the barrel at two places only and does not touch it intermittently. This makes intermittent contact unlikely. A floating fore-end is one which is not in contact with the barrel at all, but is secured to a projection from the action body. This is rare. A semi-floating fore-end is a fore-end which is fixed to the barrel by a single screw near the action body and which is floated out so that, except near this point of connection, it does not touch the barrel. If you have a semi-floating fore-end, make sure that it is, in fact, semi-floating, and that a postcard or something thicker can be passed freely between the fore-end and the barrel from the tip to near the screw that fixes it to the barrel. If there is any suggestion of contact, the fore-end should be floated out more to free it or, alternatively, converted to a two-point fore-end by inserting a slip of leather moderately tightly between the tip of the fore-end and the barrel.

Rest Shooting

The accuracy of rifles and ammunition can be tested by shooting from a rest, so as to exclude to a great extent or entirely the human error. The following are recognised methods:

1. Resting the wrist of the left hand on a sand-bag in any shooting position. A good shot, with practice, can take very steady aim this way.

2. Supporting the muzzle on a shooting table with rifle at shoulder and held with the right hand only. This position requires care to keep the contact identical from shot to shot.

3. A six-point rest can be made by cutting two V-notches in a wooden box of suitable size. The fore-end rests in these, which give four of the six points of support. The rifle is pushed forward until the trigger-guard stops against

the box (the fifth point), and rotation is prevented by a block of wood screwed on the box at the side of the trigger-guard (the sixth point). If the box is screwed to a firm base and the rifle loaded and fired, care being taken to keep the six contacts, it will throw the best group of which it is capable.

Standards of Accuracy

A rifle is considered to be accurate if, when consistently aimed and used with good ammunition, it will group within a circle of 3 inches diameter at 100 yards. A very accurate or " gilt edge " rifle will make a ten-shot group in a circle of 1½ inches diameter at 100 yards.

CHAPTER IV

GUNPOWDERS

The charges of muzzle-loading guns consisted of the powder, the ball or shot, and the wads which kept powder and shot in position and helped to develop pressure when the charge of powder was ignited. They were fired by means of a match, or spark struck by a flint on to a priming of fine powder, or else by a percussion cap arranged outside the barrel. Modern breech-loading arms are loaded with *fixed rounds* or *cartridges* in which powder and shot are assembled in a *cartridge case* which incorporates the *percussion cap* at the base of the cartridge.

Gunpowder

Explosives used in guns are known as *propellants*, and are contrasted with high explosives, which have a shattering effect or *brisance*. If a high explosive were to be fired in the chamber of a gun, the violence of the explosion would be so great that the gun would be burst. On the other hand, a propellant is capable of burning comparatively slowly so as to develop gas pressure progressively as the bullet moves down the barrel, leaving more and more space to be filled by the gases as they are produced.

A propellant powder should have the properties of regularity of performance, ready ignition, insensitivity to shock, and stability during storage. It should not produce a corrosive residue or tend to cause excessive erosion during combustion. It should not produce smoke. These properties of a powder depend mostly on chemical composition; but rate of burning is also controlled by the size, shape and surface treatment of the grains.

For many centuries black powder was the only powder used. At first it was of poor quality, but now, mixed in the proportions of 75, 15 and 10 per cent. respectively of potassium nitrate, charcoal and sulphur, is a very good propellant, and is still used for this purpose when smoke does not matter—for example, in the charges of punt guns. English black powder is of particularly good quality, and is admitted by the Americans to be superior to their own product.

The propellants known as *nitro-powders* because they consist of compounds of nitrogen are classed chemically as *nitro-cellulose powders*, if they contain nitro-cellulose; and *double-base powders*, if they contain both nitro-glycerine and nitro-cellulose. Nitro-glycerine and nitro-cellulose are prepared by treating glycerine and cellulose respectively with concentrated nitric acid together with sulphuric acid, which is added to prevent water from interfering with the reaction. Nitro-glycerine produces very hot gases liable to cause erosion of the chamber of a rifle, which is one of the reasons for the use of double-base powders, in which nitro-cellulose is in greater proportion than nitro-glycerine.

Nitro-powders are also classed according to their physical properties as *non-porous gelatinised powders*, *porous gelatinised powders* and *fibrous powders*. Non-porous gelatinised powders are made by treating nitro-cellulose with solvents so as to form a gelatinous substance which can be pressed into rods or tubes, or rolled and cut into grains. The shapes and sizes of these particles are designed to give the desired speed and constancy of burning. For example, cordite, as used in the ·303 cartridge, is a hollow tube the exterior and interior surfaces of which burn at the same time, with the result that, as the exterior surface grows smaller, the interior increases, and so the rate of burning is more or less constant until the whole of the powder is consumed. A somewhat similar effect is produced by making the powder in the form of thin, flat flakes. Conversely, powders consisting of cubical or spherical grains commence by burning rapidly, but the rate of gas production quickly falls off.

Porous gelatinous powders are made by mixing a soluble granular substance with the powder and dissolving it out, after the grains have been formed, so as to give the powder a spongy consistency. This increases speed of burning and makes the explosive more easy to ignite.

Fibrous powders are made from nitro-cellulose initially a fibrous substance -rolled into minute balls, which are then treated to render them hard so as to keep their form during handling and the filling of cartridges. These are easily penetrated by the hot gases of the explosion and ignite freely.

Progressive powder was the name originally given to a powder in which the progressive quality was obtained by introducing substances in the outer layers so as to reduce the initial rate of burning.

It is now more loosely applied to any powder which gives off gas at a more or less constant rate, instead of at a rapidly reducing rate.

Bulk powder is a name given to a shotgun powder which is prepared in such a manner that it has approximately the same properties as an equal bulk of black powder and can therefore be loaded accurately with black powder measures or machines. A bulk powder is described as a 33-grain bulk powder if a 3-drachm black powder measure holds 33 grains of it. The opposite to a bulk powder is a *dense powder*, which has much more power, bulk for bulk, than black powder.

Powders for use in rifles vary according to the weight of bullet and pressure intended, but generally they resemble one another in that they are intended to produce gas for almost as long as the bullet is in the barrel. As a contrast, pistol powders all burn rapidly, for they have to develop the whole of their power before the bullet has left a short barrel, and they must burn satisfactorily at the low pressures which the comparatively weak structure of a pistol permits. Shotgun powders are mostly quick burning in order that the maximum pressure occurs near the breech, where the barrel is sufficiently thick to withstand it, for shotguns are very thin near the muzzle.

Blank powder used in blank cartridges for starting guns at sporting events, or in military manœuvres or other occasions when a noise only is required, is a powder which is fast burning in order that it shall explode with a loud report when not under the pressure produced by the resistance of a bullet. It is not safe to load a bullet in front of a blank cartridge, as this might produce a detonation and burst the gun.

Black powder is sometimes used in blank cartridges, but other propellants are useless for this purpose : if an ordinary rifle or pistol cartridge has the bullet removed before it is fired, it produces hardly any report, for the cap composition blows the powder out of the barrel without igniting it.

CHAPTER V

CARTRIDGES FOR RIFLED ARMS

CARTRIDGES used in rifled arms are called *metallic ammunition* because the cases are made entirely of metal, whereas those of most shotgun cartridges are largely made of paper. Metallic cartridges are either *rim fire* or *central fire*, according to the type of ignition.

A rim fire cartridge has a case formed of one piece of thin, soft metal such as copper, brass or cupro-nickel, and has the cap composition spun into a narrow rim at the base of the cartridge. The cartridge is fired by the firing pin falling on the rim and crushing the composition within it.

A central fire cartridge is more heavily constructed of brass and is fired by a separate percussion cap or *primer*, which is let into the *cap chamber*, a recess in the base of the cartridge. The firing pin strikes this cap centrally, crushing the cap composition between the metal of the cap and the *anvil*, a separate piece of metal inserted in the cap, or a projection formed in the case. The hot gases escape through vents in the base of the cartridge and ignite the powder.

CALIBRE

The *calibre* of a rifled weapon is the bore diameter given in inches or millimetres, according to country of origin. In America stated calibres are often nominal, and not true descriptions of the actual bore diameter.

PERCUSSION CAPS

Cap composition is a substance which is sufficiently sensitive to explode on receiving a blow. One such composition is a mixture of potassium chlorate and antimony sulphide; another a mixture of potassium chlorate and fulminate of mercury. The former of these lacks sensitivity, the latter does not give as good an igniting flame as when combined with the former. A more effective combination is the *three-element* cap composition, which contains fulminate of mercury, stibnite (the natural mineral form of antimony sulphide) and potassium chlorate. There are several

three-element cap compositions in use, including that used for the British Service ·303 cartridge.

Three-element cap compositions are sensitive and efficient, and certain of them have been found reliable for storage in hot, damp climates. This is the reason that they are used for military purposes. But mercury is liable to combine with, and weaken, the brass of a cartridge-case, and the reaction of the explosion produces, from potassium chlorate, potassium chloride, which collects water from the atmosphere and sets up rusting in the barrel.

This rusting, which is known as *after rusting*, cannot be prevented by ordinary cleaning or oiling, for after a barrel has been cleaned by passing a brush or patch through it, and after it has been oiled, some potassium chloride remains in the bottoms of the microscopic scratches on its interior, and if the moisture content of the air is sufficient, rusting is liable to take place. The one effective way of preventing after rusting is to wash out with water.

Modern ·22 ammunition and the caps of some modern shotgun cartridges contain a cap composition which is free from both potassium chlorate and mercury and has instead a substance known as guanyl nitro-amino-guanyl-tetracene, or briefly "tetracene". The addition of this to barium nitrate and styphnate produces a stable, sensitive and non-rusting cap composition.

The discovery of a non-rusting cap composition has revolutionised small-bore rifle shooting, for it has done away with the necessity for cleaning ·22 rifles after they have been used. A rifle which has been used with ordinary ammunition must be cleaned the same day, or the barrel will be almost certainly rusted, but a rifle in which a ·22 rim-fire non-rusting cartridge has been fired is actually protected from corrosion by the coating of harmless cap composition residue which is left inside the barrel. This does not apply to shotgun cartridges with non-corrosive caps, for the charge of cap composition in them is too small in proportion to the interior surface of barrel for it to be able to afford protection.

Non-corrosive cap composition is not yet in general use for military cartridges, one reason being that it causes too noticeable a flash when the barrel is hot. In America sporting ammunition is made with non-corrosive primers, but so far in England the great majority of cartridges remain of the corrosive type because

chlorate primers are particularly suitable for use with the English powders, are reliable and store well in the tropical countries where much English ammunition is used.

The performance of the cap of a central fire cartridge is affected by the pressure developed when the cap composition explodes. If there is too much space in the cap, or the flash hole from the cap chamber to the space occupied by the charge is too large, the flame passing into the body of the charge may not be sufficiently intense to give good ignition. Some continental caps are notorious for their irregular performance.

If the composition of a cap is not good, it may cause a misfire, or else a hangfire—*i.e.* a delay between the falling of the firing pin and the explosion of the charge. A hangfire can be dangerous, for the cartridge may explode after the breech had been opened to eject it.

For target shooting, good-quality caps are essential; for poor ignition gives irregular pressures, with consequent bad grouping on the target. The defect is not, however, always due to the cap or the composition in it, but frequently results from a weak striker spring or similar defect, such as too short a firing pin, excessive head space or dirt in the mechanism.

In the design of a cartridge the cap has to be matched with the charge, otherwise there is the danger of either inadequate or excessive pressure. For example, a cap intended for use in a high-pressure rifle cartridge would probably cause an accident if inserted in a pistol cartridge; while a pistol cap might fail to ignite the charge in a rifle cartridge.

Caps are tested by manufacturers by being dropped on to a firing pin. A weight of 2 oz. from a height of 14 inches should fire a shotgun cap; 4 oz. dropped from a height of 10 inches should fire a pistol cap.

Gas Escape

The escape of gas from the breech of a rifle is prevented by the cartridge. This is known as *obturation*. The pressure of the gas on the sides of the cartridge stretches the cartridge so that it tightly fills the chamber, preventing any gas from leaking past it to the rear. The cartridge must fit the chamber so exactly that while it can be easily inserted, it does not stretch sufficiently to split. Also it must not be stretched beyond the *elastic limit*

of the material of which it is made, or it will not shrink sufficiently after the pressure has fallen, and will therefore be difficult to extract.

Difficulty of extracting ·22 copper cartridges is sometimes the sign of an over-large chamber, in which case the trouble can sometimes be cured by using brass or cupro-nickel cartridges, which spring back better than copper.

Like a cartridge in the chamber of a rifle, so the cap in the pocket at the base of the cartridge is expanded by the explosion of the cap composition and the charge, and prevents gas escape. Gas escape, when it occurs, is more often a sign of insufficient than excessive pressure.

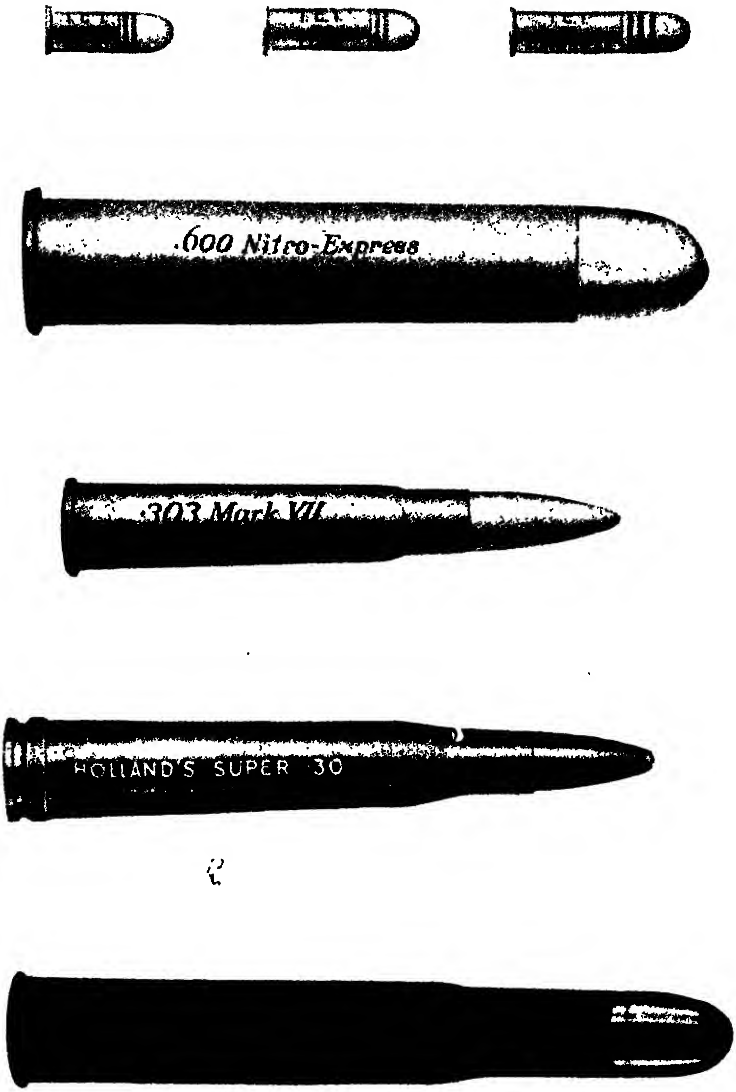
Cartridge Cases

Brass cartridge cases are pressed out of sheet brass progressively in several stages. As each stage of the pressing work-hardens the metal, the case has to be annealed several times during manufacture; but as the completed cartridge case needs to be of just the right degree of hardness, neither soft nor brittle, some work is done on it after the final annealing. Generally, it has to be harder at the head end, for the head has to withstand the backward pressure of the gases and is not completely supported against lateral expansion.

On the other hand, cartridges which are too hard in the body may split longitudinally if the chamber of the rifle is large. But a circumferential split about ½ inch from the head, while possibly due to brittle brass, is more likely to be an indication of excessive head space in the rifle. Splitting of the neck or shoulder of a bottle-neck case, which takes place during long period storage, is known as *season cracking*, and is due to crystallisation of the metal with age.

Metallic Cartridges

Rim-fire cartridges and the majority of central-fire cartridges, particularly those of early design, have a projecting rim at the head which provides a ledge against which the extractor can act, and also prevents the cartridge from going too far into the chamber. When a rimmed (or flanged, as it is often termed) cartridge is used, the *head space*—*i.e.* the space between the breech face and the surface which prevents the cartridge from going in too far—is a short distance which can be machined and gauged



PURDEY ·465.

FIG. 4.—METALLIC CARTRIDGES.

The first three cartridges are rimfire. The Holland's Super ·30 is belted. The remainder are flanged central fire cartridges.

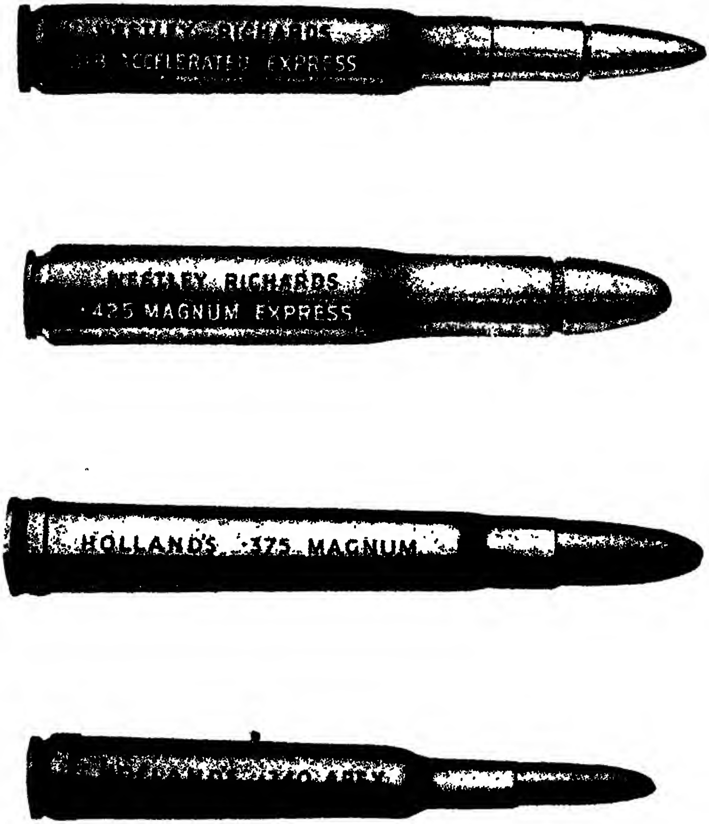


FIG. 5.—METALLIC CARTRIDGES.
The first two cartridges are rimless. The second two are belted.
Below : BULLETS CUT FROM STAGS, SHOWING MUSHROOMING.

accurately without difficulty. This, as will be explained, is important.

The rim, however, has one marked disadvantage, for when flanged cartridges are used in double-column magazines of repeating weapons or in the feeds of automatic arms, the rim of the cartridge being fed into the chamber may catch on that following and cause a mal-function. To overcome this difficulty rimless cartridges were designed, on which, in place of the projecting rim, a groove was turned to receive the hook of the extractor. The disadvantage of these was that the head space was the distance between the head of the cartridge and either the slope of the shoulders or the edge of the throat, which, being a comparatively long distance, was more difficult to maintain accurately in manufacture.

A third type of cartridge was designed which, like the rimless, had a groove to receive the extractor, but ahead of this was a belt of very shallow depth which served the sole purpose of maintaining accurate head space. This type is known as the belted cartridge. The shallow belt does not interfere with feed from a magazine, but does keep the cartridge from going into the chamber farther than it should (see Figs. 4 and 5).

Semi-rimless cartridges are similar to rimless, except that the extreme rear end of the cartridge is very slightly larger in diameter than any other part.

At the present time flanged, semi-rimless, rimless and belted cartridges are all used, according to the type of arm for which they are made. With few exceptions, all double-barrelled rifles are made for flanged cartridges, also single-shot rifles such as the Farquharson action. Most magazine rifles (excluding the British service rifle described herein) take an ordinary rimless cartridge, which is also usual for automatic and self-loading weapons. The belted rimless type is not so very common, the best examples being the ·300 and ·375 Holland Magnums.

Head Space

When a rifle is fired, the thin-walled end of the cartridge near the throat expands and is held firmly against the sides of the chamber, but the thicker-walled portion near the head, because it does not expand so much owing to its thickness, is not held so firmly and, unless the head is closely supported by the breech face, it may move backwards tearing the last half-inch of the cartridge

off from the rest. This permits gas to escape from the breech, with, most probably, disastrous results.

To avoid this danger, head space is gauged accurately with head-space gauges or heading gauges, which are in sets of three.

To gauge a chamber for head space, precautions have to be taken. With bolt-action rifles it is advisable to remove the firing mechanism and extractor. In no case should the bolt lever be forced down with the gauge in the chamber: if any resistance is felt it should be considered that the gauge is not accepted.

For gauging the Lee-Enfield No. 1 rifle Mark III, the No. 3 rifle (P.'14) and the No. 4 rifle Mark I, the bolt should close over a ·064 gauge but not over a ·074 gauge. In case of the No. 1 and No. 4 rifles, if the bolt is found to close over the ·074 H.S. gauge the dummy bolthead gauge should be substituted for the existing bolthead.

A moderate excess of head space may not perhaps be dangerous in a low-pressure ·22 rifle, although gas escape without rupture of cartridge has been blamed on this cause. The writer has fired several shots with a ·22 Martini in which the head space was so great that the head of each cartridge bulged visibly. It is, however, best to assume that any rifle with excessive head space is not safe to use. Apart from risks attached thereto, too great a head space causes misfires because either the firing pin does not extend far enough to properly indent the cartridge, or else the cartridge, not being supported, moves away from the blow.

Bullets

Lead is the principal ingredient of all bullets, for it is the material of highest specific gravity of any that can be obtained at reasonable cost: platinum and gold would probably make far better bullets than lead, and would undoubtedly be used were they not rare and expensive metals! Pure lead is now seldom used, because the addition of a small quantity of antimony or arsenic produces a harder bullet with little loss of specific gravity.

By *lead bullets* is meant bullets which are made wholly of lead alloy and which are not cased with a harder metal. Lead bullets are limited to use in weapons which are designed for muzzle velocities not exceeding about 1,500 feet per second, because a cartridge giving a higher velocity than this produces a temperature sufficient to melt the base of a lead bullet.

Gas-check bullets are bullets made mainly of lead but having a copper cup pressed on to the base to protect the lead from the heat of the powder gases. These can be shot with heavy charges giving velocities in the region of 2,000 feet per second.

Metal cased bullets are used in high-pressure, smokeless-powder cartridges which produce velocities sufficient not merely to melt the base of a lead bullet, but the sides also. They are of two types : *solid* or *full-jacketed bullets*, which are covered with harder metal over point, sides and the edges of the base (these include military cartridges); and expanding, *soft-point* and *hollow-point bullets* which have the lead of the nose exposed or a cavity in the nose respectively.

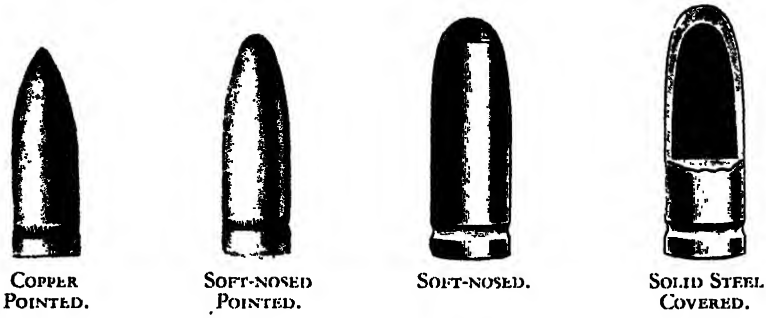


FIG. 6.—BIG GAME BULLETS.

All these are expanding bullets except the steel covered, which is for use against elephant, rhinoceros, etc.

A soft lead bullet is suitable for target practice at low velocities or against soft-skinned game, but its powers of penetration are limited and it quickly deforms or spatters out if it meets with a hard substance. A fully jacketed bullet has good penetration : with sufficient velocity it will pass through a steel plate, but is liable to pass through an animal without bringing it down. To ensure that the energy of the bullet may be used to the full, the bullet should be so designed that it expands on impact by just the amount necessary to prevent if from passing right through. Thus, an easily expanding bullet is used for soft-skinned game, but a heavy bullet with less tendency to expand is used for dangerous game on which a bullet suitable for lighter game would produce a surface injury only. (See Fig. 6.)

Methods of making a bullet expand include the provision of a

hollow point, as, for example, in the hollow-point ·22 sporting cartridge; a soft nose of lead in a jacketed bullet; a hollow-point, soft-nosed bullet; and various devices. In the design of soft-nosed bullets, the amount of lead exposed is varied according to the degree of expansion desired.

Revolver bullets have velocities too low to cause effective hydraulic shock or to expand satisfactorily. They therefore need to be heavy to have stopping power. This is the reason that military revolvers are of large calibre. Pistols and revolvers are not of much use against large animals.

The materials most commonly used for bullet jackets are copper alloys including gilding metal, an alloy of copper with 5 to 10 per cent. of zinc. Where deep penetration through thick, bony structure is required, as for example for the frontal shot on an elephant, I.C.I. make bullet jackets of steel coated with gilding metal. Examples are the ·404, ·416, ·465 and ·470 calibres. Cupro-nickel or German silver was once the usual material for coating bullets, but caused heavy nickel fouling of the barrel. While not so strong as cupro-nickel, gilding metal was found to be less expensive and was adopted for sporting ammunition. It did not cause lumpy metal fouling.

Spherical lead bullets are now obsolete because they do not overcome the resistance of the air nearly as well as a long, "conical" bullet. Modern bullets are all "conical" bullets of various shapes, including bullets of cylindrical form with flat points in order that they may be used in tube magazines without danger of the point of the bullet firing the cap of the next on recoil of the rifle; round-nose bullets; sharp-pointed bullets; boat-tailed bullets, which are moderately streamlined; and completely streamlined bullets.

The measure of the ability of a bullet to overcome air resistance is known as the *ballistic coefficient*, and is found by dividing the *sectional density* by the *coefficient of form*. The sectional density is the ratio of weight to the diameter as expressed by the formula:

$$\frac{W}{d^2}$$

where W = the bullet-weight in pounds.
d = the diameter of the bullet in inches.

The coefficient of form relates to the shape of the *ogive* of the

TABLE I

Standard Ballistics of I.C.I. Central-fire Metallic Cartridges

Cartridge	Bullet weight, grns.	Barrel length, ins.	Coefficient of form n	Coefficient of ballistic C	Muzzle Velocity, f.s.	Muzzle Energy, ft.-lb.	100 yds. Velocity, f.s.	100 yds. Energy, ft.-lb.	Max. height of trajectory (ins.) over range of: 50 yds.	100 yds.	200 yds.
·22" Hornet	45	29	1·11	0·12	2,500	625	2,080	430	—	0·8	4·2
·297/·230" (Morris) Short	37	26	1·30	0·077	875	63	715	42	1·6	6·9	—
,, ,,	[illegible]	27½	1·30	0·077	1,200	118	915	69	0·9	4·1	—
·240" Flanged Nitro Express (Holland)	[illegible]	28	1·24	0·20	2,775	1,710	2,517	1,405	—	0·6	2·7
·240" Belted Rimless Nitro Express (Holland)	100	28	1·24	0·20	2,900	1,870	2,641	1,550	—	0·5	2·4
,, ,, ,, ,,	75	21½	—	—	3,500	2,035	3,204	1,710	—	—	—
6·35 mm. (·25") Auto Pistol	50	2	1·14	0·10	750	63	634	45	2·1	9·2	—
·297/·250" Rook Rifle	56	27	1·28	0·10	1,150	165	940	110	0·9	4·1	—
6·5 mm. (·256") Mannlicher (Dutch)	160	31	1·72	0·193	2,350	1,960	2,084	1,550	—	0·9	4·0
6·5 mm. (·256") Mannlicher-Schonauer	160	25¼	1·72	0·193	2,300	1,880	2,030	1,475	—	0·9	4·2
6·5 mm. (·256") Mauser (Portuguese)	155	29	1·33	0·24	2,400	1,980	2,188	1,650	—	0·8	3·5
·256" Magnum (Gibbs)	145	28	1·07	0·277	2,600	2,180	2,415	1,880	—	0·7	3·0
·275" Belted Rimless Magnum Nitro Express (Holland)	160	28	1·05	0·266	2,675	2,540	2,481	2,180	—	0·6	2·8
·275" Rimless (Rigby)	140	28	1·00	0·248	2,750	2,350	2,542	2,010	—	0·6	2·7
,, ,,	173	28	1·20	0·256	2,400	2,215	2,201	1,860	—	0·8	3·6
7 mm. (·276") Mauser (Spanish)	173	29	1·20	0·256	2,300	2,035	2,102	1,700	—	0·9	3·9
,, ,, ,,	140	29	1·00	0·248	2,900	2,615	2,691	2,250	—	0·5	2·4
·280" Flanged Nitro Express	160	28	1·15	0·24	2,600	2,400	2,387	2,030	—	0·7	3·0
,, ,, ,,	140	28	1·15	0·21	2,800	2,440	2,555	2,030	—	0·6	2·7
,, ,, ,,	180	28	1·04	0·30	2,425	2,350	2,255	2,030	—	0·8	3·4
·280" Rimless Nitro Express (Ross)	160	28	1·15	0·24	2,700	2,600	2,480	2,200	—	0·6	2·8
,, ,, ,,	140	28	1·15	0·21	2,900	2,610	2,653	2,190	—	0·6	2·5
,, ,, ,,	180	25	1·04	0·30	2,525	2,550	2,351	2,210	—	0·7	3·1
Super ·30" Magnum Flanged (Holland)	150	28	1·10	0·204	2,875	2,750	2,022	2,285	—	0·6	2·5
,, ,, ,, ,,	180	28	1·20	0·226	2,575	2,650	2,349	2,210	—	0·7	3·1
,, ,, ,, ,,	220	28	1·15	0·258	2,250	2,470	2,074	2,100	—	0·9	4·0
Super ·30" Magnum Rimless (Holland)	150	28	1·10	0·204	3,000	3,000	2,745	2,500	—	0·5	2·2
,, ,, ,, ,,	180	28	1·20	0·226	2,700	2,915	2,473	2,450	—	0·6	2·8
,, ,, ,, ,,	220	28	1·15	0·258	2,350	2,700	2,173	2,300	—	0·8	3·7
·30" (7·63 mm.) Mauser Auto Pistol	85	5½	1·25	0·10	1,400	370	1,030	202	0·7	3·1	—
·300" (·295") Rook Rifle	80	27½	1·27	0·10	1,100	216	914	148	1·0	4·3	—
·300" Sherwood	140	27½	1·24	0·187	1,400	610	1,157	416	0·6	2·7	—
·30" Rimless (Springfield '06)	220	26	1·13	0·268	2,200	2,360	2,010	1,980	—	1·0	4·3
,, ,, ,,	180	26	1·01	0·25	2,700	2,915	2,494	2,484	—	0·6	2·7
,, ,, ,,	150	26	1·16	0·194	2,800	2,610	2,530	1,920	—	0·6	2·7
·30-30" Winchester	170	20	1·3	0·197	1,950	1,440	1,707	1,100	—	1·3	6·0

7·65 mm. (·32") Auto Pistol or ·30" Browning Pistol	72	3½	1·27	0·094	925	136	763	93	1·4	6·3	—
7·65 mm. Parabellum	92	5	1·21	0·115	1,200	295	985	198	1·0	4·2	—
·303" British (Mark 6)	215	25	1·28	0·25	2,050	2,000	1,853	1,690	—	1·1	5·0
·303" British	192	25	1·19	0·24	2,200	2,065	1,989	1,690	—	1·0	4·4
·303" British (Mark 7)	174	25	1·0	0·258	2,450	2,315	2,253	1,960	—	0·8	3·4
·303" British	150	25	1·03	0·218	2,700	2,430	2,464	2,025	—	0·6	2·9
·303" Savage	180	22	1·65	0·163	1,975	1,560	1,682	1,130	—	1·3	6·1
·310" Cadet (Greener)	120	26	1·2	0·136	1,200	384	1,000	270	0·8	3·6	—
7·9 mm. (·311") Mauser (German)	227	29	1·4	0·225	2,075	2,170	1,857	1,740	—	1·1	5·0
„ „ „	154	29	1·05	0·20	2,875	2,830	2,616	2,340	—	0·6	2·5
8 mm. (·315") Mannlicher (Austrian, Bulgarian and Greek)	244	30	1·4	0·231	2,100	2,390	1,984	1,920	—	1·1	4·9
8 mm. (·315") Mannlicher–Schonauer	200	29	1·31	0·210	2,200	2,150	1,959	1,700	—	1·0	4·5
·318" Rimless Nitro Express	250	28	1·27	0·256	2,400	3,200	2,191	2,660	—	0·8	3·6
„ „ „	180	28	1·18	0·20	2,700	2,900	2,443	2,380	—	0·7	2·9
·32" S. & W. Revolver	85	3	1·30	0·095	600	68	504	48	3·3	14·4	—
·32" S. & W. Long	98	3½	1·21	0·117	700	106	605	81	2·4	10·4	—
·320" Revolver	80	3	1·23	0·097	550	54	464	38	3·9	17·1	—
·32" (·32-20") Winchester	115	25	1·13	0·15	1,400	501	1,214	317	0·6	2·8	—
·32-40" Marlin & Winchester	165	20	1·32	0·175	1,650	1,000	1,400	720	—	1·9	8·9
·333" Rimless Nitro Express	300	28	1·25	0·315	2,200	3,220	2,039	2,765	—	1·0	4·2
„ „ „	250	26	1·07	0·30	2,500	3,480	2,330	3,010	—	0·7	3·2
·35" Winchester	250	24	1·26	0·231	2,200	2,690	1,981	2,180	—	1·0	[illegible]
·400/·350" Flanged Nitro Express	310	25	1·13	0·309	2,000	2,750	1,842	2,335	—	1·2	[illegible]
·350" Magnum (Rigby) (S.P.S.N. only)	225	24	1·10	0·230	2,625	3,440	2,401	2,380	—	0·7	3·0
·351" Winchester self-loading	180	20	1·39	0·15	1,800	1,300	1,495	894	—	1·6	7·8
9 mm. Parabellum Auto Pistol	124	4	1·22	0·115	1,100	333	935	241	1·0	4·2	—
9 mm. Mannlicher–Schonauer	245	22½	1·23	0·226	2,100	2,400	1,880	1,920	—	1·1	4·9
9 mm. Mauser	245	[illegible]	1·23	0·225	2,150	2,515	1,926	2,015	—	1·0	4·7
·360" Nitro Expr ..	300	[illegible]	1·22	0·261	1,650	1,810	1,478	1,460	—	1·8	8·0
·360" Nitro for Black Powder Express	190	[illegible]	1·38	0·145	1,650	1,150	1,354	773	—	1·9	9·5
9·3 mm. Mauser	285	24	1·45	0·21	2,250	3,200	2,009	2,550	—	1·0	4·3
·369" Purdey Nitro Express	[illegible]	31	1·14	0·24	2,525	3,615	2,312	3,210	—	0·7	3·2
9·5 mm. Mannlicher Schonauer	270	25	1·27	0·214	2,150	2,770	1,910	2,200	—	1·0	4·7
·375" Rimless Nitro Express	270	25	1·27	0·214	2,100	2,640	1,868	2,090	—	1·1	4·9
·375" Flanged Nitro Express	270	25	1·27	0·214	1,975	2,340	1,750	1,840	—	1·2	5·6
·400/·375" Nitro Express (Holland)	270	28	1·15	0·235	2,175	2,840	1,903	2,310	—	1·0	4·5
·375" Flanged Magnum Nitro Express (Holland)	300	28	1·25	0·241	2,425	3,910	2,216	3,260	—	0·8	3·5
„ „ „ „	270	[illegible]	1·15	0·238	2,600	4,060	2,385	3,410	—	0·7	3·0
„ „ „ „	235	25	1·10	0·218	2,750	3,930	2,513	3,285	—	0·6	2·7
·375" Belted Rimless Magnum Nitro Express (Holland)	300	28	1·25	0·244	2,500	4,150	2,291	3,490	—	0·8	3·3
„ „ „ „	270	28	1·15	0·238	2,650	4,210	2,435	3,550	—	0·7	2·9
„ „ „ „	235	28	1·10	0·218	2,800	4,070	2,563	3,410	—	0·6	2·6
·38" S. & W. Revolver	145	4	1·28	0·125	625	126	548	97	2·9	12·6	—
·38-200" or ·380" Mk. I (for Mk. IV Revolver)	200	4	1·4	0·158	600	160	540	129	3·1	13·3	—

TABLE I—*continued*

Cartridge	Bullet weight, grms.	Barrel length, ins.	Coefficient of form n.	Coefficient of ballistic C.	Muzzle Velocity, f. s.	Muzzle Energy, ft.-lb.	100 yds. Velocity, f./s.	100 yds. Energy, ft.-lb.	Maximum height of trajectory (ins.) over range of 50 yds.	100 yds.	200 yds.
·38″ S. & W. "Special"	158	6½	1·28	0·130	875	268	782	215	1·5	6·3	—
·380″ Revolver	124	4	1·27	0·10	625	108	530	78	3·0	13·1	—
·380″ Long Rifle	124	20½	1·27	0·20	1,050	304	883	214	1·1	4·7	—
·380″ Auto Hammerless Pistol or ·380″ Auto Webley or 9 mm. Short Auto Pistol	[illegible]	3½	1·3	0·083	850	152	705	104	1·6	7·2	—
·38″ Auto Pistol	130	6	1·32	0·10	1,100	349	914	241	1·0	4·3	—
·400 Purdey 3″	230	20½	1·5	0·133	2,050	2,150	1,687	1,455	—	1·3	6·1
·450/·400″ Nitro Express 3″	400	30	1·21	0·251	2,125	4,010	1,946	3,360	—	1·0	4·6
·450/·400″ Magnum Nitro Express 3¼″	400	26	1·21	0·281	2,150	4,110	1,970	3,440	—	1·0	4·6
·401″ Winchester self-loading	200	20	1·5	0·115	2,125	2,010	1,705	1,290	—	1·2	6·1
·404″ Rimless Nitro Express	400	28	1·37	0·250	2,125	4,010	1,925	3,285	—	1·0	4·7
·405″ Winchester	300	24	1·21	0·210	2,200	3,230	1,960	2,560	—	1·0	4·5
·416″ Rigby	400	26	1·24	0·267	2,300	4,700	2,110	3,950	—	0·9	3·9
″	410	20	1·27	0·267	2,300	4,810	2,110	4,050	—	0·9	3·9
10·75 mm. (·423″) Mauser	317	24	1·28	0·217	2,175	3,050	1,943	2,910	—	1·0	4·6
·44–40″ Winchester	200	24	1·37	0·115	1,300	750	1,025	466	0·7	3·4	—
·45″ Colt Auto Pistol	200	5	1·32	0·107	870	337	753	252	1·5	6·6	—
·45″ Colt Auto Pistol (U.S.A.)	230	5	1·16	0·14	800	327	710	258	1·8	7·7	—
·450″ Revolver	225	6	1·21	0·128	700	245	615	189	2·3	10·0	—
·450″ Nitro Express	480	28	0·81	0·418	2,150	4,930	1,960	4,100	—	1·0	4·5
·577/·450″ Solid Martini-Henry, Black	480	33	1·08	0·294	1,350	1,945	1,194	1,520	—	2·7	12·0
″ ″ ″ ″	325	33	1·06	0·210	1,600	1,850	1,319	1,255	—	2·0	9·9
·577/·450″ Solid Martini-Henry, Cordite	480	33	1·08	0·294	1,350	1,945	1,194	1,520	—	2·7	12·0
″ ″ ″	370	33	0·95	0·261	1,425	1,665	1,234	1,250	—	2·5	11·3
·455″ Revolver	265	6	1·22	0·15	600	212	538	170	3·2	13·4	
·500/·465″ Nitro Express	480	28	1·10	0·286	2,150	4,950	1,876	3,750	—	1·1	4·9
·470″ Nitro Express	500	31	0·82	0·39	2,125	5,010	1,923	4,100	—	1·0	4·7
·475″ No. 2 Nitro Express	480	28	0·80	0·369	2,200	5,170	1,983	4,200	—	1·0	4·4
·475″ No. 2 Nitro Express (for Jeffery rifles)	500	28	1·0	0·30	2,120	5,000	1,861	3,850	—	1·1	5·0
·500 Nitro Express 3″	570	28	0·80	0·393	2,150	5,850	1,948	4,800	—	1·0	4·6
·500″ Nitro for Black Powder Express 3″	440	28	0·97	0·25	1,900	3,530	1,617	2,560	—	1·4	6·6
·505″ Gibbs Magnum	525	26	1·02	0·30	2,300	6,180	2,028	4,800	—	0·9	4·2
·577″ Solid Snider	480	36	1·49	0·14	1,250	1,660	1,034	1,140	—	3·4	16·2
·577″ Nitro Express 3″	650	28	1·05	0·26	1,950	5,500	1,672	4,040	—	1·3	6·2
″ ″	750	28	1·05	0·30	2,050	7,010	1,797	5,380	—	1·2	5·4
·600″ Nitro Express (powder charge 100 grms.)	900	28	1·30	0·258	1,850	6,840	1,582	5,010	—	1·5	6·9
″ ″ ″ 110 ″	900	28	1·30	0·258	1,950	7,600	1,066	5,550	—	1·3	6·2

bullet—*i.e.* the curve of the nose. Coefficients of form and ballistic coefficients for I.C.I. ammunition are as given in Table 1.

Lead bullets have *cannelures* in their parallel sides which are filled with grease or wax to prevent particles of lead from adhering to the inside of the barrel and causing leading, which tends to build up and interfere with accuracy. If the cannelures are exposed, the bullets are described as *outside lubricated.* This type of greasing is objectionable for sporting cartridges, because it prevents them from being carried loose in the pocket. *Inside lubricated* bullets have the greased portion of the bullet inside the case, so that the grease does not pick up dirt and is not wiped off in handling. Many lead bullets for rim-fire cartridges, including high-velocity ·22 Long Rifle cartridges and revolver cartridges, are electro-plated with copper and/or lubricated with hard wax, which makes them suitable for carrying loose in the pocket.

Bullets are held into the necks of cartridge cases by making the case a tight fit for the bullet (friction type); by crimping the mouth of the case into a cannelure on the bullet; by both a friction-type fit and a crimp edge; or by indentation, the neck of the case being pressed into the bullet at a number of points. If a bullet is not sufficiently firmly held, it may, in the case of a hand-arm, blow out too easily for the explosion to properly develop. Conversely, a loose bullet can be knocked into the cartridge case while in the magazine of a rifle or hand-arm, thereby causing excessive pressure when the cartridge is fired.

·22 Ammunition

For sporting and target shooting with the ·22 rifle, the cartridges given in Table 2 are listed by Imperial Chemical Industries. Of these, Long Rifle "Rifle Club" and Long Rifle "Standard" are used for target-shooting, while all have uses for small game and vermin-shooting. In addition to those listed in the table, special grades are occasionally issued for competition purposes.

Short or Long ·22 cartridges *can* be used in rifles chambered for the Long Rifle cartridge; but it is not advisable to do so, because hot gases escape past a bullet not seated in the leed and quickly erode the chamber.

Practically all ·22 ammunition available is smokeless non-rusting, and the rifleman who is shooting regularly can with safety leave his rifle uncleaned indefinitely. It is necessary only to

clean and oil if the rifle is to be put away for a considerable period or in a damp place.

This, however, only applies to ammunition of known origin. There exist in the store cupboards of clubs and elsewhere odd

TABLE 2

Ballistics of I.C.I. ·22 Rimfire Ammunition

	Bullet weight, grains	Muzzle			25 yds.			50 yds.		
		Vel., f./s.	En., ft.-lb.	Drop, in.	Vel., f./s.	En., ft.-lb.	Drop, in.	Vel., f./s.	En., ft. lb.	Drop, in.
·22 L.R. High-vel.	40	1,400	174	—	1,272	144	0·6	1,169	121	2·5
·22 L.R. Rifle Club	40	1,200	128	—	1,111	110	0·8	1,053	98	3·3
·22 L.R. Standard	40	1,025	93	—	980	85	1·1	938	78	4·4
·22 Long High vel.	30	1,375	126	—	1,215	98	0·6	1,102	81	2·7
·22 Long Standard	30	1,025	70	—	966	62	1·1	913	55	4·5
·22 Short High-vel.	30	1,150	88	—	1,060	75	0·9	996	66	3·7
·22 Short Standard	30	925	57	—	876	51	1·3	843	46	5·5
		75 yds.			100 yds.			125 yds.		
·22 L.R. High-vel.	40	1,090	103	6·1	1,036	95	11·4	991	87	18·7
·22 L.R. Rifle Club	40	1,005	90	7·8	962	82	14·5	922	76	23·5
·22 L.R. Standard	40	900	72	10·2	865	67	18·7	833	62	30·1
·22 Long High-vel.	30	1,028	70	6·6	968	62	12·5	915	56	20·8
·22 Long Standard	30	865	50	10·5	822	45	19·5	781	40	32·5
·22 Short High-vel.	30	940	59	8·7	890	53	16·1	845	47	26·2
·22 Short Standard	30	791	42	12·7	751	38	23·5	712	34	38·1
		150 yds.			200 yds.			300 yds.		
·22 L.R. High-vel.	40	947	80	28·3	874	68	55	749	50	149
·22 L.R. Rifle Club	40	885	69	35·1	820	60	67	700	43	171
·22 L.R. Standard	40	801	57	44·7	741	49	84	629	35	215
·22 Long High-vel.	30	868	50	31·6	784	41	62			
·22 Long Standard	30	741	36	47·5	665	29	91			
·22 Short High-vel.	30	803	43	39·5	723	35	76			
·22 Short Standard	30	674	30	57·0	603	24	109			

boxes of ammunition which may be of the corrosive kind, or boxes of mixed rounds some of which may be corrosive. It is not advisable to use these, and if they are used (for sporting purposes, for mixed rounds are of no use in competitions), the rifle should be immediately cleaned with hot water.

It is often said that if different brands of rustless ammunition are used consecutively without cleaning, the mixing of the fouling may produce a corrosive substance. This is possibly a conjecture that has grown up into a belief, for Townsend Whelen, the well-known American small-arms expert, states that he has never found anything to sustain the contention, and the author has never experienced trouble from this cause.

Batch Variation of ·22 Ammunition

Rifles of ·22 calibre are very sensitive to minute differences of ammunition such as result from the unavoidable wear of bullet- and cartridge-making dies. It is not merely a matter of using a particular brand of ammunition: one rifle may shoot well with one *batch* and badly with another of the same brand, while a second rifle may shoot better with the batch of ammunition which does not suit the first. This can be a matter of bullet size, for a rifle with a worn barrel of over-large size may shoot very well if used with a batch of ammunition in which the bullets are of more than normal diameter.

Expert target-shots study the results obtained with different batches of ammunition and buy up as large stocks as they can of those most suited to their rifles. This is a reason for the target rifleman, when applying for a firearms certificate, to state that he requires to purchase at any one time and to hold in stock comparatively large quantities of ammunition. Of recent years it has been more particularly necessary to hold large stocks of ammunition, owing to temporary shortages of supply.

The ·22 Cartridge for Sport

At one time central-fire rook and rabbit cartridges of ·295, ·300 and similar calibres were used for shooting vermin and small ground game. Today ·22 rim-fire cartridges are almost invariably used for these purposes, because they are much cheaper and more accurate. The ·22 short, long and long rifle cartridges are suitable for shooting small vermin such as rats and grey squirrels and small birds, and are quite effective for well-placed shots on rabbits, hares and some larger birds. But while the ·22 cartridge should be considered dangerous and capable of killing men * or larger animals if a bullet accidentally penetrates a vital part, it cannot be considered satisfactory for shooting any but the smaller birds, ground game or vermin: for no sportsman wants to mortally wound an animal, yet let it get away. For sport it is best to use the long-rifle high-velocity cartridge with hollow-point bullet, and aim at the head only of game larger than can be killed by a shot almost anywhere; unless it is desired not to disturb game, when the standard long rifle cartridge has the advantage of making very little noise.

* A ·22 Short cartridge has caused a fatality at nearly half a mile range.

The Hornet Cartridge

The ·22 Hornet is perhaps best for use on small game up to ranges of 175 yards. It is a bottle-shaped central-fire cartridge, and therefore cannot be used in a rifle chambered for ordinary ·22 ammunition. It is much more expensive than any ·22 rim-fire cartridge, but it has the attraction not only of much greater killing power but of being far *safer* to use, for a soft-nosed high-velocity bullet breaks up on hitting the ground, unless used at excessive range, and virtually does away with the danger of ricochets, which are so likely to occur when any ·22 rim-fire cartridge is used.

The Hornet cartridge gives a velocity of 2,500 feet per second to a 45-grain metal-cased bullet. It is very accurate, has a low trajectory, and provides good sport for rabbit-stalking or shore-shooting when used in a heavy-barrelled rifle fitted with a telescopic sight. It is suitable for all small English game, all vermin and wildfowl, and is effective on foxes at ranges up to 200 yards. As the bullet energy is powerful, shots should be taken at the head only, to avoid damage to meat.

Cleaning Ammunition

Service rifle ammunition and chargers, and all metallic ammunition not externally lubricated, should be cleaned before use. This particularly applies to ·303 ammunition used in competitions, for the presence of oil on the exterior of the cartridge case lets it move backwards, increasing the pressure on the bolt and altering the flick of the barrel.

Some externally lubricated ammunition—*e.g.* having waxed lubricated bullets—is, supplied clean, and should not be cleaned. But ordinary ·22 ammunition is greased all over and is often noticeably dirty with dust or vegetable fibre. In this condition it is liable to fail to eject from tight chambers of Martini action rifles. The cases of such ammunition should be cleaned with a rag, and dirt removed from the bullet, but the bullet should be left slightly greasy in the cannelures, and should be evenly greased all round, for complete removal of grease from one side only can cause inaccuracy.

Storage

Ammunition is best stored in air-tight tins with press lids, and in a cool place.

CHAPTER VI

SHOTGUN CARTRIDGES

THE two main parts of a shotgun cartridge case are the paper tube and the brass head.

The paper tubes are made by rolling and pasting the paper into tubes, drying and conditioning to controlled moisture content, polishing and sizing the tubes to exact diameters, and cutting them to length.

The brass head is made of three or four components, excluding the cap and cap chamber, which are inserted in it. These are an iron disc which strengthens the head, an iron lining (for gas-tight cases only), a rolled paper base-wad, and the brass head itself. The cap chamber is a cylindrical cup with rim at the open end which is pressed out of brass sheet, annealed, cleaned and pierced for the flash vent.

The case is assembled by machinery in such a manner that it becomes virtually one piece, after which, when the cap has been placed in its chamber, the cartridge is ready for loading with powder, shot and wads.

Cartridge cases are classed as *narrow head* if the depth of the brass head is $\frac{5}{16}$ inch, *deep shell* if the depth of the brass head is $\frac{5}{8}$ inch, and *gas-tight* if the case has an iron lining to the powder chamber. *Water-resisting* cases are made of paper which has been treated so as to be almost waterproof. These are usually also gas-tight.

The bore or gauge of a shotgun is given in terms of the number of spherical lead balls of diameter equal to the bore that go to a pound. Thus, twelve equal-size spherical lead balls weighing a pound would each fit the barrel of a 12-bore gun. There is an exception to this rule in the ·410 gun, the bore of which is given as a decimal of an inch.

Shotgun cartridges are also made in different lengths, which are given in inches, and so, when buying cartridges, it is necessary to specify both bore and cartridge length.

The usual 12-bore cartridge is a nominal $2\frac{1}{2}$ inches long, $2\frac{3}{4}$ inches is normal for pigeon guns, 3 inches for wildfowling. The

standard American case is $2\frac{5}{8}$ inches long, as compared with the $2\frac{1}{2}$ inches English standard.

It is often said that a cartridge of longer case than a gun is built to take should never be used in that gun, as this would cause excessive pressure and the possibility of a burst, for if the cartridge is too long the turnover extends into the cone, constricting the diameter of the bore. Actually, tests have shown that pressure is only slightly increased by the turnover extending into the cone of the chamber; and the theory is now being advanced that using $2\frac{3}{4}$-inch cases in guns chambered for $2\frac{1}{2}$-inch cases is not dangerous *provided that the charge of powder and shot is not greater than that for which the gun has been proved.* For the danger of using a longer cartridge is that a long cartridge normally contains a heavier charge than a shorter cartridge.

Loading Shotgun Cartridges

Shotgun cartridges are loaded in the following order: powder; over-powder card; felt wad; over-felt card; shot; and over-shot card. The *wads*, which include the felt wad and the aforementioned cards, are of considerable importance, greatly affecting the performance of the cartridge.

The felt wad is the most important, because it serves the purpose of sealing the bore and prevents the powder gases from leaking past the shot. It should be of very good quality white felt, a material which is ideal because it can be manufactured in consistent quality, and it should be greased. Low-grade felts are not to be recommended. Air-cushion wads, which are stout paper tubes with the ends closed and which should be used with $\frac{1}{8}$-inch thick over-powder wads, are also considered very suitable. Cork is also used but has disadvantages.

The over-powder card in an ordinary cartridge serves the purpose of protecting the powder from the grease on the felt wad. It is about $\frac{1}{12}$ inch in thickness, or slightly more. The over-felt card, which keeps the shot from sticking to the felt or penetrating it, is of similar thickness. The over-shot card, which keeps the shot from falling out of the cartridge case, is generally much thinner—*e.g.* $\frac{1}{16}$ inch thick. It is secured in position by the *turnover*—*i.e.* the turning in and back upon itself of the top edge of the paper tube. This turnover should be so constructed that a pull of 45 lb. is required to straighten it out and fetch the over-

shot wad out of the cartridge; for if the resistance is not sufficient, the pressure of the powder gases will not develop sufficiently for complete combustion. (See Fig. 7.)

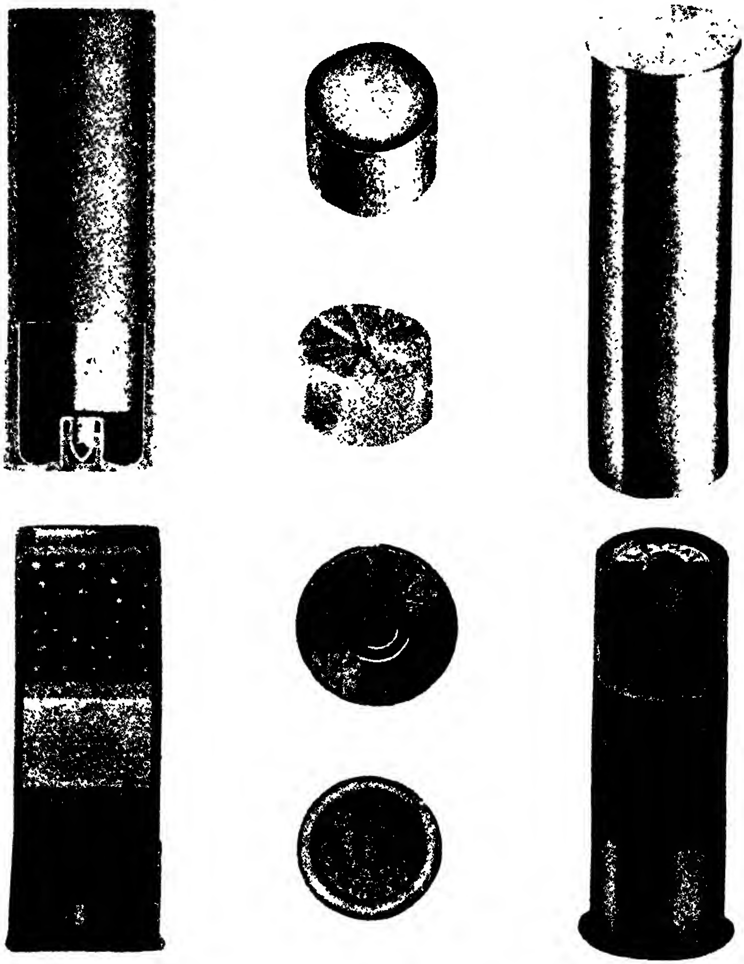


FIG. 7.—*Above:* SECTION OF GAS-TIGHT CARTRIDGE CASE. FELT WAD. AIR-CUSHION WAD. "THIN BRASS" CARTRIDGE.

Below: SECTION OF SHOTGUN CARTRIDGE. BASE OF CARTRIDGE. OVERSHOT WAD. CARTRIDGE WITH "LETHAL" BULLET.

The last can be used in either a choke or a cylinder barrel of an ordinary shotgun against big game.

Crimped Turnover

The over-shot card is liable to get in the way of the shot and spoil the pattern. This has been overcome by the invention of the fully crimped cartridge, which, in place of an over-shot card and turnover, is closed by having the sides of the paper tube crimped towards the centre and pressed in.

Shot

Shot is made by dropping molten lead down a tower about 200 feet high, during which process surface tension causes the molten lead to form and congeal into more or less spherical drops. The size of the drops is controlled by varying the temperature of the lead and the sizes of the holes in a perforated pan or sieve through which the lead is passed. Antimony and arsenic are added to promote the formation of circular drops, the former element also producing an alloy harder than pure lead. The stream of shot drops into a tub of water which is placed at the bottom of the tower to break the fall and prevent deformation of the pellets.

After drying, the shot is sieved for size and sorted for shape by rolling the pellets down a sloping surface: the spherical pellets roll at a greater speed, and jump a gap into which the deformed pellets fall.

Large shot which cannot be made by the aforementioned process is cast in moulds and fettled.

Shot Velocity

The usual velocity of shot from the 2½-inch 12-bore cartridge is about 1,050 feet per second—a little less than the speed of sound—as observed over the first 20 yards of range, which is the standard distance adopted in Great Britain for measuring shotgun velocity.

The velocity of shot from a shotgun is limited, for shot is small and round and easily retarded by the resistance of the air. Reduction of the charge of shot and increase of the powder charge increase the muzzle velocity, but as the muzzle velocity increases the resistance of the air increases by a greater amount, and the observed velocity over a distance of 20 yards is not greatly increased.

The practical velocity of shot from a shotgun is limited for

TABLE 3

Comparison of British and Foreign Shot Sizes

(Approximations only)

English	American		Belgian	Canadian	Dutch	French	German	Italian		Spanish			Swedish	Turkish	
	Eastern Buck-shot	Western Buck-shot								Linares English type	Barce-lona Figueroa type	Sevilla Mata type			
LG	000	2	—	—	—	—	II	—	—	—	—	—	—	—	—
MG (mould)	00	3	—	—	—	C.1	—	—	—	—	—	—	—	—	—
SG	0	4	—	—	—	—	III	—	—	—	—	—	—	—	—
Special SG	1	5 or 6	—	SG	—	C.2	IV	—	—	—	—	—	—	—	—
SSG	2	7	—	—	—	C.3	V	—	—	—	—	—	—	—	18/A
SSSG	3 or 4	8 or 9	—	—	—	C.4	—	—	—	—	—	—	—	—	17/A
SSSG	FF		—	AAAA or 12 Seal	—	C.4 bis	VI	—	—	—	—	—	—	—	16/A
SSSSG or AAAA	TT		—	AA	—	—	000000	7/0	—	7/0	—	—	—	—	1[illegible]/A
AAA	T		—	A	—	5/0	00000	6/0	—	6/0	—	—	11	4/0	14/A or 13/A
AA	BBB		—	BBB	—	4/0	0000	5/0	—	—	—	—	10	3/0	12/A
A or BBBB	BB		5/0	BB	—	2/0	00	3/0	—	4/0	—	—	9	0	11/A
BBB	B		4/0	B	0	0	0	2/0 or 1/0	—	3/0	—	—	8	1	10/A
BB	1		3/0	1	[illegible]	1	1	—	—	—	—	—	7	2	9/A
B	2		2/0	2	1	—	1	1	—	2/0	1	—	—	—	8/A
1	3		0	[illegible]	3	2	2	2	00	1	—	—	6	3	7/A
2	—		2	—	4 or 5	3	3	3	0 or 1	—	4	—	5	4	6/A
3	4		3	4	—	4	4	—	2	2	5	—	4	5	5/A
4	5		4	5	G.6	5	5	4	3	—	—	4	3	6	4/A
4½	—		—	—	—	—	—	—	4	4	6	5	—	—	—
5	6		5	[illegible]	F 6	—	—	5	—	—	—	6	2	—	3/A
5½ (m.g.)	—		—	—	—	6	6	6	5	—	—	—	—	7	—
6	—		6	—	—	—	—	—	—	5	7	7	1	—	2/A
6½	7		6½	7	—	7	7	—	6	—	—	—	—	8	—
7	7½		7	7½	7	—	—	7	7	6	8	—	0	—	1/A
8	8		8	8	8	8	8	8	8	7	—	9	—	9	1/0
9	9		9	9	9	9	9	9	9	8	—	10	00	10	2/0
10	10		10	10	10	10	10	—	—	9	11	11	000	11	—
11	—		11	—	11	—	—	—	—	10	—	—	—	—	3/0
12	11		12	—	12	11	11	—	11	—	—	12	—	12	—
Dust	12		—	—	—	12	12	—	14	—	—	—	—	13	—

Table 4

Eley Lead Shot (Standard and "Chilled")

Name	No. of pellets per oz.	No. of pellets per $1\frac{1}{16}$ oz.	Weight in grs.	Diameter in in.	Diameter in mm.
LG	6	6	70·00	0·360	9·14
MG (mould)	7	7	62·50	0·347	8·81
SG	8	9	54·70	0·332	8·43
Special SG	11	12	39·80	0·298	7·57
SSG	15	16	29·17	0·269	6·83
SSSG	20	21	21·89	0·245	6·22
SSSSG	25	27	17·50	0·227	5·77
SSSSSG or AAAA	30	32	14·58	0·214	5·44
AAA	35	37	12·50	0·203	5·16
AA	40	43	10·94	0·194	4·93
A or BBBB	50	53	8·75	0·18[illegible]	4·57
BBB	60	64	7·29	0·170	4·32
BB	70	74	6·25	0·161	4·09
B	80	85	5·47	0·154	3·91
1	100	106	4·38	0·143	3·63
2	120	127	3·65	0·135	3·43
3	140	149	3·12	0·128	3·25
4	170	181	2·57	0·120	3·05
4½	200	213	2·19	0·113	2·87
5	220	234	1·99	0·110	2·79
5½ (m.g.)	240	255	1·82	0·107	2·72
6	270	287	1·62	0·102	2·59
6½	300	319	1·46	0·099	2·51
7	340	361	1·29	0·095	2·41
8	450	478	0·97	0·087	2·21
9	580	616	0·75	0·080	2·03
10	850	903	0·52	0·070	1·78
11	1,040	1,099	0·42	0·066	1·68
12	1,250	1,328	0·35	0·062	1·57
Dust	2,600	2,750	0·17	0·048	1·22

Table 5

Relative Sizes of Shot

Size	Pellets to 1 oz.					
	British	American	French	Italian	German	Belgian
1	100	72	74	79	75	104
3	140	107	99	120	112	140
4	170	134	113	175	140	172
5	220	170	170	220	178	218
6	270	220	221	270	231	270
7	340	295	260	340	308	340
8	450	404	402	450	422	450

TABLE 6

Pellets in Game Charges

Oz. of shot	Size of shot					
	3	4	5	6	7	8
$1\frac{1}{2}$	210	255	330	405	510	675
$1\frac{7}{16}$	201	244	316	388	489	646
$1\frac{3}{8}$	192	234	303	371	468	618
$1\frac{5}{16}$	183	223	289	354	446	590
$1\frac{1}{4}$	175	213	275	338	425	562
$1\frac{3}{16}$	166	202	261	321	404	534
$1\frac{1}{8}$	157	191	248	304	383	506
$1\frac{1}{16}$	149	181	234	287	361	478
One	140	170	220	270	340	450
$\frac{15}{16}$	131	159	206	253	319	422
$\frac{7}{8}$	122	149	193	236	298	394
$\frac{13}{16}$	113	138	179	219	276	366
$\frac{3}{4}$	105	128	165	202	255	338
$\frac{11}{16}$	96	117	151	186	234	310
$\frac{5}{8}$	[illegible]	106	138	169	212	282
$\frac{9}{16}$	78	96	124	152	191	254
$\frac{1}{2}$	70	85	110	135	170	225

TABLE 7

Mean Velocity Over Range

In feet-per-sec. from gun to object for Standard Game Cartridges.

Size of shot	Range, in yds.					
	20	30	35	40	45	50
3	1,070	989	953	919	883	849
4	1,070	981	942	905	869	833
5	1,070	975	933	892	853	814
6	1,070	969	925	880	837	796
7	1,070	925	912	865	819	775

TABLE 8

Striking Velocity

In feet-per-sec. at various ranges for Standard Game Cartridges.

Size of shot	Range, in yds.					
	20	30	35	40	45	[illegible]
3	915	804	753	704	657	612
4	906	788	735	683	635	587
5	893	768	711	656	604	555
6	883	752	691	634	579	528
7	871	731	667	606	549	496

TABLE 9

Striking Energy

Striking energy in foot-pounds for individual pellets at different distances for Standard Game Cartridges.

Size of shot	Range, in yds.					
	20	30	35	40	45	50
3	5·79	5·68	3·92	3·43	2·98	2·59
4	4·68	3·54	3·03	2·66	2·34	1·96
5	3·52	2·60	2·23	1·90	1·61	1·36
6	2·79	2·03	1·71	1·44	1·20	1·00
7	2·20	1·53	1·27	1·05	0·86	0·70

several reasons. Reduction of weight of shot lowers pressure, and so if the shot load is too greatly reduced no extra velocity is secured.

Also the charges of shot and powder that can be used in a gun are limited by the maximum recoil that can be tolerated by a shooter. To some extent recoil can be reduced by increasing weight of gun, but again there is a limit to the weight a sportsman is prepared to carry round with him. Furthermore, an excessive powder charge increases muzzle blast and spoils the pattern.

POWDER CHARGES AND SHOT SIZES

In wildfowling, ranges are long, and to effect penetration on large birds at long range large shot is used. This size of shot would kill small birds, but as the number of pellets in the charge is small, there would always be the chance of the bird escaping by flying through the pattern without being hit. Sportsmen and cartridge manufacturers have therefore arrived at opinions (not by any means unanimous) as to sizes of shot suitable for different kinds of shooting, the general rule being that the size of pellet increases with the size of the bird. The recommendations given in Table 10 are given by Imperial Chemical Industries in *The Shooter's Year Book* for 1950. Size 6 is by far the most popular of any shot used.

Table 12 shows the ranges at which various sizes of shot pellets lose their killing power. These ranges are calculated on a minimum effective striking energy of ·85 ft.-lbs., the figure usually taken as a standard in such calculations. The figure may

vary on either side to about ·5 ft.-lbs. for snipe and similar small birds, and up to 1·5 ft.-lbs. for geese, etc.

The ranges given are the maxima for *individual shot pellets*;

TABLE 10

Shot Sizes for Specific Purposes

Game	Shot size
Boar	Spherical Ball or LG
Destroying Crow Nests or Squirrel Dreys	BB
Duck	4 or 5
Gazelle	BB or 1
Geese	BB or 1
Grouse	6 or 7
Partridge	6 or 7
Pheasant	5 or 6
Pigeon	5 or 6
Rabbits	5 or 6
Snipe	8
Squirrels	6 or 7
Woodcock	7 or 8

TABLE 11

Standard Loads for Smokeless Powders Only

This table gives the shot charges which are used in standard factory loaded cartridges.

Bore or gauge	Length of case, in ins.	Shot charge, in oz.
4	4	3
8	$3\frac{1}{4}$	2
10	$2\frac{7}{8}$	$1\frac{7}{16}$
10	$2\frac{5}{8}$	[illegible] $\frac{5}{16}$
12	3	[illegible] $\frac{\ }{8}$
12	$2\frac{3}{4}$	$1\frac{1}{4}$
12	$2\frac{1}{2}$	$1\frac{1}{8}$
12	$2\frac{1}{2}$	$1\frac{1}{16}$
12	$2\frac{1}{2}$	1
12	2	$\frac{7}{8}$
16	$2\frac{3}{4}$	1
16	$2\frac{1}{2}$	$\frac{15}{16}$
20	$2\frac{3}{4}$	$\frac{7}{8}$
20	$2\frac{1}{2}$	$\frac{13}{16}$
28	$2\frac{1}{2}$	$\frac{9}{16}$
·410	$2\frac{1}{2}$	$\frac{7}{16}$
·410	2	$\frac{5}{16}$

For any selected powder the charge and the wadding are fixed to give a standard mean velocity of approximately 1,070 f.p.s. over 20 yds., without exceeding the pressure for which the gun has been proved. The mean velocity over 20 yds. for a ·410 cartridge is approximately 975 f.p.s.

pattern density has an equally important effect on the maximum range of a whole shot charge. Variations in gun boring, shot loads and shot sizes make it difficult to lay down figures for

TABLE 12

Maximum Effective Range of Individual Pellets of Standard Game Cartridges

Size of shot	Range, in yds.
BB	127
1	104
3	85
4	75
5	63
6	55
7	46
8	36

pattern density; the only hint that can be given here is that, with all but the smallest sizes of shot or the heaviest shot loads from special large-bore wildfowling guns, pattern density fails long before pellet energy.

TABLE 13

Pellets in 30-in.-circle Standard Loads (1 1/16 oz. Shot)

Conditions / Range in yds.	30	35	40	45	50	55	60
No. 4 Shot (181 pellets):							
True Cylinder . .	109	89	72	60	47	38	31
Improved Cylinder .	130	110	91	76	60	49	40
Half Choke . . .	150	129	109	91	72	58	47
Full Choke . . .	181	152	127	107	89	72	58
No. 5 Shot (234 pellets):							
True Cylinder . .	140	115	94	77	61	49	40
Improved Cylinder .	168	143	117	98	77	63	51
Half Choke . . .	194	166	140	117	94	75	61
Full Choke . . .	234	196	164	138	115	94	75
No. 6 Shot (287 pellets):							
True Cylinder . .	172	141	115	95	75	60	49
Improved Cylinder .	207	175	144	120	95	77	63
Half Choke . . .	238	204	172	144	115	92	75
Full Choke . . .	287	241	201	169	141	115	92
No. 7 Shot (361 pellets):							
True Cylinder . .	217	177	144	119	94	76	61
Improved Cylinder .	260	220	181	151	119	97	79
Half Choke . . .	299	256	217	181	144	115	94
Full Choke . . .	361	303	253	213	177	144	115

TABLE 14

Pellets in 30-in.-circle Standard Loads (1⅛-oz. Shot)

Conditions \ Range in yds.	30	35	40	45	50	55	60
No. 4 Shot (191 pellets):							
True Cylinder	115	94	76	63	50	40	32
Improved Cylinder	138	117	96	80	63	52	42
Half Choke	159	136	115	96	76	61	50
Full Choke	191	160	134	113	94	76	61
No. 5 Shot (248 pellets):							
True Cylinder	149	122	99	82	64	52	42
Improved Cylinder	179	151	124	104	82	67	55
Half Choke	206	176	149	124	99	79	64
Full Choke	248	208	174	146	122	99	79
No. 6 Shot (304 pellets):							
True Cylinder	182	149	122	100	79	64	52
Improved Cylinder	219	185	152	128	100	82	67
Half Choke	252	216	182	152	122	97	79
Full Choke	304	255	213	179	149	122	97
No. 7 Shot (383 pellets):							
True Cylinder	230	188	153	126	100	80	65
Improved Cylinder	276	233	191	161	126	103	84
Half Choke	318	272	230	191	153	123	100
Full Choke	383	322	268	226	188	153	123

PATTERNS AT ALL RANGES

Tables 13 and 14 are confined to the $1\frac{1}{16}$-oz. and 1⅛-oz. charges and to shot sizes Nos. 4, 5, 6 and 7. But sportsmen knowing the total pellets in the charge (see Table 6) may calculate values corresponding to those contained in the tables in question. They require to know the percentage only of total pellets in the 30-inch circle for four borings of gun at the ranges stated, which are as given in Table 15.

TABLE 15

Range, in yds.	True cylinder percentage	Improved cylinder percentage	Half choke percentage	Full choke percentage
30	60	72	83	100
35	49	61	71	84
40	40	50	60	70
45	33	42	50	59
50	26	33	40	49
55	21	27	32	40
60	17	22	26	32

Example: Charge $1\frac{1}{16}$ oz. No. 5, find pattern at 50 yds. for a half-choke barrel. Total pellets, 234, multiplied by 40 (from Table 15) and divided by 100. Answer 93·6, say 94.

Ball Ammunition for Shotguns

Formerly, a number of makes of cartridge containing a single bullet for shooting big game at close quarters, as for example in lion-shooting, were made for use in suitable shotguns. These

Table 16

Diameter of Spread

This is the diameter in ins. covered by the bulk of the charge of a gun at various ranges for all calibres.

Boring of gun	Range, in yds.						
	10	15	20	25	30	35	40
True Cylinder .	19	26	32	38	44	51	57
Improved Cylinder	15	20	26	32	38	44	51
Half Choke . .	12	16	20	26	32	38	46
Full Choke . .	9	12	16	21	26	32	40

were known as *ball* cartridges. They have almost become obsolete, one remaining being the cartridge shown in section on Fig. 7, which was designed for use in either the choke or cylinder barrels of an ordinary shotgun. Special *ball-and-shot* guns rifled at the muzzle only (and therefore legally classed as rifles), such as the Holland and Holland " Paradox " and the Westley Richards " Explora ", were at one time popular.

Saloon Rifle Ammunition

Saloon rifle ammunition is the name given to the very smallest ammunition made. It includes ·22 spread shot cartridges and ·22 metallic cartridges, some of which have no explosive charge other than the cap composition. These cartridges have little practical interest for riflemen or sportsmen.

Storage of Shotgun Cartridges

Cartridges should be stored in conditions which will not permit them to become damp or excessively dry. A hot cupboard makes the paper brittle and the powder violent. Damp expands the case and loosens the turnover.

CHAPTER VII

THE PARTS OF A RIFLE

THE main metal parts of a rifle are the *barrel*, the *action body* and the *action*. The foremost tip of the barrel is the *muzzle*, behind which is fixed the *foresight*. The rearmost end of the barrel screws into the action body, and at this point the barrel is usually thickened at the *reinforce*. A small flat on the top surface of the reinforce, which is usual on military rifles and, incidentally, the B.S.A. 12/15 target rifle, is known as *Nock's form*, so named after an old-time gunsmith, and now commonly referred to as *Knox form*. The purpose of this is to provide a plain surface to which foresight, backsight, action body, etc., can be related during assembly, in order that none is out of vertical when the rifle is completed.

The action body contains the action, including the *breech-block*, by which the breech is closed. In a bolt-action rifle the breech-block is the *bolt*. Below the action may be seen the *trigger*, protected by the *trigger guard*.

The *backsight* of a rifle with open sights is mounted on the barrel towards the rear end. But if the rifle has an aperture backsight, this is mounted on the action body or on the *strap*, which is a projecting strip of metal used to connect the action body to the butt of some rifles with two-piece stocks, or sometimes to the bolt or part of the bolt, such as the cocking-piece.

The *stock*, which is usually of hardwood, although comparatively recently plastic stocks have been made in America, is either a *one-piece* stock or a *two-piece* stock, depending on whether or not the fore-end is in one piece with the butt. The *fore-end* is that part of the stock which is carried forward under the barrel. The *butt* extends from the action body rearwards. That part of the butt which is of narrow cross-section and lies immediately behind the action body is known as the *hand*, for it is here that the stock is gripped by the right hand of the shooter. Below this there may be a downward projection known as the *pistol grip*, because of its similarity in shape to the grip of an old-time pistol.

The hand of a rifle is round or oval in shape, and widens in cross-section as it approaches the pistol-grip cap. The hand of a

good-quality shotgun is more diamond-shaped than round in cross-section, this being comfortable because it fits the bones of the hand.

The top edge of the butt is called the *comb*. Possibly this strange name is borrowed, for the top edge of the cock of an old-time firearm was known as the comb because it resembled a cock's comb. Later, the roughened backward projection of the hammer of guns, rifles and pistols was known as the comb of the hammer, and presumably the comb of the butt is so called because it also is the top edge of a component located near to the hammer.

The rearmost top corner of the butt is the *bump* or *heel*; the rearmost bottom corner the *toe*. On the side of the stock which

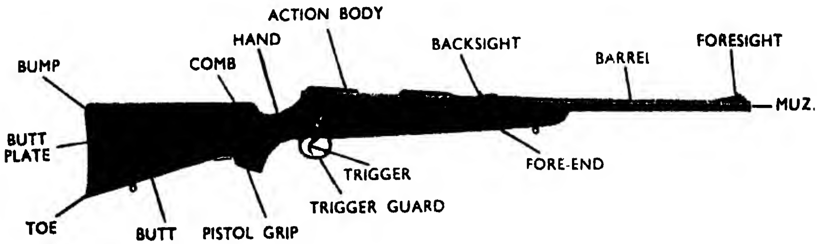


FIG. 8.—THE PRINCIPAL PARTS OF A RIFLE.
Illustrated: B.S.A. MODEL D SPORTING RIFLE.

rests against the cheek may be fitted or carved a *cheek piece*. On the rear face of the butt is sometimes fixed a *butt plate* or *heel plate* of metal, horn, plastic or rubber. Good-quality shotguns are usually without this because it adds to the weight, and is unnecessary if the gun is carefully handled.

Sling attachments are fixed, one to the barrel or tip of the fore-end, and another near to the butt or rear of the fore-end, according to the purpose for which the sling is to be used. A military rifle usually has sling-swivels fixed to a *barrel band* which holds the stock in position, and near the rear of the butt; a target rifle usually has a sling-swivel at each end of a long fore-end.

Military rifles have one or two additional pieces of wood fixed over the barrel. These are called *handguards*, and their purpose is to protect the soldier's hand from the barrel, which in prolonged fire may become too hot to hold. The addition of these extra sections does not change the nomenclature of the stock, which

remains one-piece or two-piece, according to whether the fore-end is or is not in one with the butt.

The *magazine* of a repeating or a self-loading rifle is the container for the ammunition. This may be a *box magazine*, in which the cartridges lie flat, one above another, and are pressed upwards by the magazine *platform* under the action of the magazine spring, or it may be a *tube magazine*, in which the cartridges lie end to end in a tube and are pressed by a spring backwards towards the action. There are also other less common arrangements.

The Rifled Barrel

The barrel of a rifle has the bore running down the centre, and this is rifled into spiral *grooves*. The *lands*, which are the raised spaces between the grooves, owe their name to the term " lands " applied to the undisturbed surfaces of earth between the furrows of a ploughed field. The forward end of the barrel is the *muzzle*, the hindmost end the *breech*. At the breech end the bore is enlarged to form the *chamber*, which is shaped to receive the cartridge. That portion of the bore between the chamber and the rifled barrel is called the *throat*, and the adjacent portion where the lands are tapered outwards so as to receive the ogive of the bullet is known as the *lead*, because it leads the bullet into the rifle. (To avoid confusion of this word with lead, the material of which many bullets are made, most writers on firearms adopt the mis-spelling *leed*, which will be followed from now onwards in this text.)

The bore of the rifle is the diameter measured between lands, as opposed to the groove diameter, which is measured into the depth of the grooves. The *calibre* of a rifle is, as mentioned in Chapter 5, often nominal, being slightly different from either of the above. It is given in decimals of an inch or in millimetres, according to the country of origin.

Length of Barrel

The barrel of a rifle is made long as compared with that of a pistol so as to utilise the powder gases in the production of velocity. A pistol does not develop a high velocity in the bullet, but makes a loud bang, because much of its energy is wasted in muzzle blast.

Bullet velocity is reduced more or less as the square root of the

barrel length if an existing barrel is shortened. From this it will be observed that removing a few inches from the end of the barrel does not make a very great difference.

Target rifles have long barrels, partly because a long distance between foresight and backsight makes aiming easier; partly because a long, heavy barrel is easier to hold steady in the prone position; and perhaps also as a matter of custom. But length of barrel does not affect accuracy unless carried to extreme, and a short barrel can be very accurate.

There is, however, a limit to which the barrel can be shortened and remain accurate, for when the length is reduced too much, the bullet leaves the muzzle at a time when the pressure of the powder gases is still sufficient to distort its base. When the bullet is first set up by the pressure of the gases it is squeezed out to fit the rifling, and travels up the barrel in this condition: if the barrel is very short its base is further expanded by the muzzle blast as soon as it leaves the barrel, and has nothing to prevent it from becoming distorted. Then, of course, the bullet's flight becomes erratic.

Actions

Rifle actions are so varied in type, and so numerous are the varieties, that it is possible to describe only a few and attempt classification. Broadly, all rifles other than special military weapons fall into one of the following three classes: *single shot*, *repeater* and *self-loading* or *semi-automatic*.

The single-shot group embraces a very great variety of mechanisms, including the falling block, in which the breech is closed by a block which, on the action of a lever, rises and closes the breech, holding the cartridge in the chamber. Of the English rising-block actions the Martini (see Figs. 9 and 30), once used for the military rifle and now for target rifles, and the Farquharson (see Fig. 10), no longer manufactured, are most outstanding.

A very different single shot-action is the *snap* or *break down* action used for most shotguns and for double-barrelled big-game rifles. This will be described in the chapter on shotguns.

Rook-and-rabbit rifles were single-shot hammer or hammerless weapons, usually of snap-action type, and in general appearance similar to single-barrel shotguns. (See Fig. 10.) There were also Martini or other falling-block actions, rarely bolt actions. As the

name suggests, they were made for small game, and for this purpose were chambered to take moderate-calibre short cartridges not much longer than those used for pistols. They ceased to be manufactured owing to the rise in popularity of the ·22 rim-fire.

Under the head of repeating rifles are *lever action* repeaters, *slide action* repeaters and *bolt action* repeaters. These are again sub-divided according to whether the magazine is of the tubular type, box type or special pattern.

Self-loading rifles are sub-divided according to the means by which the force of the explosion actuates the self-loading mechanism, as will be described.

The Martini Action

The Martini action, a Swiss invention, was adopted in 1869 for use in conjunction with the Henry barrel as the weapon of the

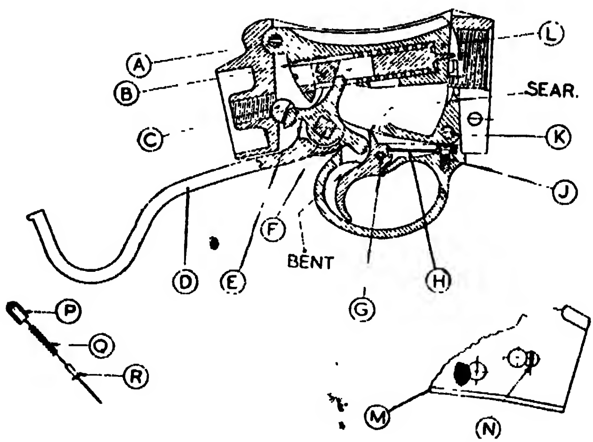


Fig. 9.—Martini Action of Greener General Purpose Shotgun.

A. Block Axis Pin. *B*. Striker Stop Nut. *C*. Safety-catch. *D*. Lever. *E*. Tumbler. *F*. Indicator. *G*. Trigger Axis Pin. *H*. Trigger Spring. *J*. Trigger Spring Screw. *K*. Extractor Axis Pin. *L*. Block. *M*. Indicator Keeper Screw. *N*. Safety-catch Keeper Screw. *P*. Detent Plunger. *Q*. Detent Spring. *R*. Spring Guide.

British Army. It was later abandoned for military purposes because, although repeating Martinis were invented, the design was not very adaptable to the repeating principle, a need for which had become apparent. Also it was found that the extraction was

not sufficiently positive for a service weapon, because sand between the cartridge and the inside of the chamber caused jamming. The bolt action overcame both these difficulties, and thus the Martini-Henry was eventually replaced by the Lee-Enfield.

The Martini, however, has remained popular in Great Britain for target-shooting. Its disadvantages disappear on the small-bore rifle range, where the use of magazines is prohibited and where conditions are such that dirt is not likely to get into the action. Its advantages are that it can be loaded "single shot" perhaps more rapidly than any other action, that under the moderate pressures produced by ·22 long-rifle cartridges it is accurate, and that in the modern improved designs it is very easy to take down, clean, oil, repair and adjust.

The modern Martini as exemplified in the action of the B.S.A. 12 or 12/15 takes out of the receiver bodily. A screw (slotted so that a coin may be used as a screw-driver, and thereby damage obviated) is withdrawn and, on a lever being lowered, the action falls out, exposing all its parts to inspection through its open skeleton sides. The various moving parts, including the block, sear, lever and extractor, may all be removed by pushing out pins. The trigger and trigger-spring are secured by screws.

The principle of the Martini action is as follows. The block, which closes the breech and contains the firing pin and main-spring, is hinged at the back in such a manner that when the front end falls the chamber is exposed. Depressing the lever underneath the action lowers the block in this manner and at the same time draws back the firing pin and engages the *sear* with the *bent*, half cocking the rifle. At the end of its movement the breech-block strikes one arm of the L-shaped extractor, and the fired cartridge is flicked out of the chamber. The new cartridge is slid by hand down a polished groove in the top of the breech-block and pushed with the forefinger into the chamber. On the lever being raised back into position the breech is closed and further pressure applied to the main-spring, fully cocking the rifle, which is then ready to be fired.

The cocking of the Martini action in two movements makes loading very smooth and easy when the chamber is perfectly matched to the ammunition. But the block of most Martini actions does not push the cartridge into the chamber, as do bolt

actions and some rising block actions, and as modern practice is to make chambers short in pursuit of accuracy, loading may be difficult, and some rifles may reject makes, batches or individual rounds of ammunition.

The Farquharson Action

Of the number of falling-block actions invented in the latter half of the nineteenth century, the best was one invented by a Mr. Farquharson of Blairgowrie. This is an action of the hammerless type and characterised by a peculiar but not unattractively shaped lever. The block moves vertically, and is supported by rebates on the side walls of the action body, for which reason, and the weight of the material used, the action is very strong. There are also no crevices of a kind likely to permit blowback into the shooter's face. When cocked, the rifle automatically goes " on safe ", the safety-catch usually being located behind the groove through which the cartridges are slipped into the chamber. When the action is closed the lever locks into position with a catch that has to be pressed with the thumb before the lever can be dropped. The rifle can be cleaned from the breech end merely by opening the action.

Actions of this type, alike in the main principles of operation but differing in detail, were manufactured by several makers, including Gibbs, Westley Richards, Holland and Holland, Jeffery, and Webley and Scott. They were incorporated in rifles of various calibres up to ·600, and Jeffery described their make as " the most powerful rifles it is possible to obtain ".

The Farquharson action was superseded by the bolt-action magazine rifle and ceased to be manufactured. But it is still of considerable interest in America because, owing to its great strength and the quality of the workmanship that was put in by the firms who made it, it is one of the most attractive actions, if not the best, for embodying in single-shot conversions for use with " wildcat " and other high-pressure " varmint " cartridges. (See Figs. 10 and 28.)

Bolt Actions

The bolt action has been adopted for all ordinary military rifles, and is very largely used throughout the world for heavy sporting rifles. In America, where lever actions and slide actions

still have their adherents, it has risen greatly in popularity because of the accuracy it makes possible and the high pressures it can withstand. In Great Britain magazine rifles are, almost without exception, of the bolt-action type, in particular imported Mauser actions specially built for incorporation in sporting rifles.

All bolt actions are alike in one respect: they incorporate a

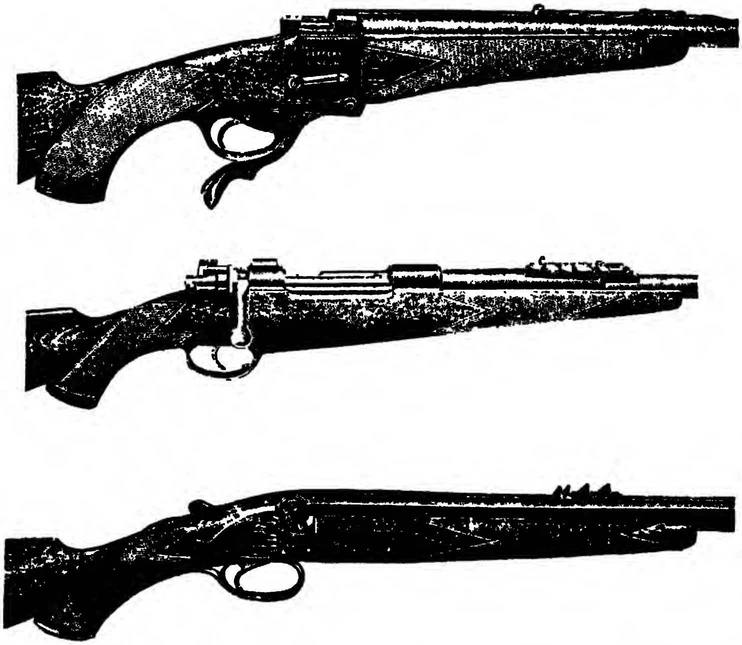


Fig. 10.—*Above:* Farquharson Falling Block Action of a Jeffery Big Game Rifle.

This action has been superseded by the bolt action, but old Farquharson actions are in demand in America for use in rifles chambered for both commercial and wildcat varmint cartridges.

Middle: Mauser Action of Jeffery ·404 Big Game Rifle.
Below: Jeffery 1912 Model Hammerless Ejector Rook Rifle.

cylindrical bolt which slides straight forward to close the breech and which, or part of which, is rotated so that locking lugs on the bolt are brought to bear against surfaces on the action body, preventing backward movement of the bolt under the pressure of the explosion gases. The firing pin and main-spring are enclosed in the bolt, and that part of the mechanism which is held

back by the sear when the rifle is cocked is known as the *cocking-piece.*

A peculiarity of all military and many other bolt-action rifles is that the trigger has a double pull—*i.e.* it moves a long distance on a light pull, followed by a short, crisp release involving a heavier pull. Because the bolt is a moving part separate from the trigger mechanism, and because it is operated with some violence in quick reloading, it is necessary that the sear should move a long distance to release the cocking-piece, so as to avoid an accidental discharge when closing the breech. This would involve too long and dragging a pull on the trigger for accurate shooting if it were not for the double-pull arrangement. The double pull is usual with military and many other bolt-action rifles, and those who are used to it have no fault to find with it. But means have comparatively recently been devised for giving a bolt-action rifle a crisp single pull.

The bolt action always incorporates one or more extractor hooks, which pull the cartridge out of the chamber when the bolt is withdrawn, and an ejector, which is a projection in some part of the action so arranged as to catch against the rear of the cartridge, throwing it out of the action.

In *straight pull* actions the bolt is drawn straight back to extract the fired case and pushed forward to feed in a fresh cartridge and lock the breech. Rotation of the locking lugs is effected by a screw mechanism in the bolt. Among these are the Austrian Mannlicher, the Swiss Schmidt-Rubin and the obsolete Canadian Ross.

More popular for all purposes are the *turning bolt* actions in which the breech is unlocked by manually lifting the bolt lever upwards before pulling back the bolt, and locked by the reverse motion. Turning bolt actions fall under three heads: (1) *Mauser* and Mauser types (see Fig. 10), including the 1903 U.S.A. model and the military rifles of most countries of the world; (2) *Mannlicher* (see Fig. 11) and other types; and (3) the Lee-Enfield, Lebel, Nagant and Krag-Jorgensen rifles.

Mauser Action

The Mauser rifle has a strong one-piece bolt without separate removable bolt-head. The locking lugs are at the front end and opposite one another: sometimes there is an extra locking lug

at the rear. The bolt lever stands straight out on the right side at the rear end of the bolt and is finished with a round knob.

A cam-shaped recess is cut at the back end of the bolt, receiving the stud of the cocking-piece, so that when the bolt lever is raised the striker is withdrawn a short distance.

The extractor is a broad spring, the front claw of which rides over the base of the cartridge engaging in the groove.

FIG. 11.—1. MANNLICHER-SCHONAUER BOLT ACTION. 2. LEE-ENFIELD BOLT ACTION. 3. MANNLICHER-SCHONAUER ACTION WITH SET TRIGGER.

All military Mauser rifles are charger loaded, with chargers in the form of strips of sheet metal, the edges of which are turned over to hold the cartridge groove. The cartridges are pushed into the magazine by one motion of the thumb, the charger being thrown out on the first forward motion of the bolt. When Mauser actions are built into sporting rifles, the ammunition then, of course, is not charger loaded.

Mannlicher (Turning Bolt) Action

The locking lugs of the Mannlicher bolt are on opposite sides of the bolt, close to the head, and set somewhat farther back than those of the Mauser, so as to permit the fitting of a separate bolt-head which does not rotate with the bolt. There is a cam recess at the end of the bolt similar to that of the Mauser and which similarly draws back the firing pin on the lever being lifted.

S.M.L.E. Rifle

The Rifle, Short, Magazine, Lee-Enfield, as it is known to the War Department, or S.M.L.E., was approved in 1902 to take the place of the Magazine Lee-Metford and Magazine Lee-Enfield or "Long Rifle", various marks of which had been in use since 1888.

The Lee-Enfield has a simple cylindrical bolt with a bent lever at the rear terminating in a round knob. On the right side of the bolt cylinder is a solid rib which moves in a slot in the rear of the action body, and opposite to this is a solid lug. The lug and the rear face of the rib bear on surfaces of the body and support the bolt when the rifle is fired.

This feature of having the support of the bolt at the rear end, and not close up to the barrel, has advantages and disadvantages. The main advantage is that there is no deep cylindrical recess in front of the action body which is difficult to keep clean under conditions of active service. The chief disadvantage is that the force of the explosion acting on the unsymmetrical central part of the action body *via* the long bolt sets up lateral vibrations, which interfere with accuracy and necessitate the setting of the foresight to the left by 0·015 inch.

The action of the bolt mechanism is as follows. On lifting the bolt-lever the cocking-piece is prevented from turning because its tongue is engaged in a groove in the body, and the bolt-head is also prevented from turning with the bolt by its hook engaging with a rim on the right side of the body. As the lever is turned a cam-face at the rear end of the bolt forces back a stud on the tongue of the cocking-piece, and this draws the striker end clear of the end of the bolt-head and partially compresses the main-spring. When the bolt is turned as far as it can go it can be drawn back, and, on the bolt being pushed forward, the full bent

of the cocking-piece engages the end of a sear, and the main-spring is further compressed. On the bolt-lever being turned down, the bolt is forced forward by reason of the sloping faces on the rear of the lug.

Lever Action Repeating Rifles

The lever action is more rapid than the bolt action, but generally is not so strong. It is typically American, and was extremely popular in America from about 1873 until the first World War. The reason for this popularity was partly fashion, but also because the lever action permitted very rapid shooting; and although the accuracy of the rifle was not of the first order, it was sufficient for the purpose, which was for shooting deer in thick forest—a circumstance in which moderate accuracy suffices and rapid operation a great advantage.

The action is used in conjunction with tube magazines or special magazines such as the rotary magazine of the Savage rifle. The principles involved are very varied, the general similarity being that lever action rifles have a lever on the underside of the body which, on being pushed downwards and forwards and returned to its original position, ejects the fired cartridge, reloads and cocks the hammer.

Several numbers of Winchester lever action repeater were loaded through a trap in the right side of the action body by pushing cartridges bullet foremost into the tubular magazine. The action of the lever on the downward (or opening) motion was to draw back the breech-block, extracting the fired case, and, cocking the hammer, force the rearmost cartridge from the tubular magazine into the carrier and, at the end of the motion, raise the carrier and cartridge so that the bullet pointed into the chamber. Returning the lever to the closed position forced the breech-block forward, pushing the cartridge into the chamber and finally locking the breech-block in position.

Slide Actions

These are the most rapid of all repeaters which are not self-loading. Loading is effected by moving backward and forward a sliding grip arranged under the barrel in lieu of a fore-end. This action is not used with very heavy calibres. It compares with the lever action for accuracy.

The tube magazine, which is usual with the slide action, does not help accuracy, for as each shot is fired the column of cartridges moves backwards, altering the balance of the rifle and tending to cause each shot to be higher than that previously fired.

Automatic and Self-loading Mechanisms

Machine-guns and fully automatic rifles, carbines and those two-handed weapons which the military refer to as automatic pistols are used for military purposes only, because they are capable of continuing to fire for as long as the trigger is pressed. This prohibits their use by the general public (see Chapter XXIII). However, semi-automatic or self-loading rifles and pistols are used for sporting and target purposes respectively. These embody the same principles as some types of fully automatic weapon, but incorporate mechanisms that ensure that the trigger must be released and pulled again for each shot that is fired.

Broadly speaking, self-loading weapons are less reliable than other types of repeating weapons, for they are liable to malfunction or jam, and this may happen at an awkward moment. Some of them cannot be used except with lubricated ammunition. They permit more rapid fire of a large number of shots than any repeater, but in sport this is a doubtful advantage, for it leads to the bad habit of not taking care in aiming the first shot, and generally tends towards injuring, as against killing, game.

The problem of devising a firearm which will load itself and continue to function without stoppages is not easy. It has absorbed the energies of inventors for years, but comparatively few patents have been successful. Briefly, the problem is to find a means by which the breech can be opened and the fired case extracted *after the bullet has left the barrel and the pressure fallen to safe limits*, utilising part of the power of the explosion.

There are three ways of doing this. The first, known as ***blowback***, is to make use of the pressure of the gases on the back of the cartridge and, by permitting the cartridge to move slightly, cause the bolt to be blown backwards and opened. The second, the ***recoil*** system, makes use of the energy provided by the recoil of a barrel which moves relative to the rest of the weapon. The third, the *gas actuation* system, involves a piston and cylinder engine which is driven by gas drawn off from the barrel at a point

near the muzzle, or elsewhere not sufficiently near the breech for the gas pressure to be dangerously high.

Blowback System

In the blowback system, while the breech-block is thrown back by the backward pressure of the powder gases exerted on the head of the cartridge, the breech-block must not move appreciably until the pressure has fallen to within safe limits, for should head space become excessive while pressure remained appreciable, the head of the cartridge would be blown backwards at a time when the front end remained held in the chamber by lateral pressure, and the cartridge would rupture.

The motion of the breech-block can be retarded in light weapons by making the block sufficiently heavy relative to the weight of the bullet. The Sten gun, which uses a pistol cartridge, adopts this principle; but a military rifle relying on the weight of the breech-block would need to have a block weighing nearly thirty pounds, which would be impracticable. Consequently other devices have to be used. For example, the Thompson sub-machine gun has a light breech-block the rearward movement of which is retarded by a special sliding wedge—it does not rely entirely on inertia, and therefore is said to have a "retarded blowback action."

Recoil Actuation

This is classed as *short-recoil* or *long-recoil*, according to the distance travelled by the barrel. The principle has been used in several classes of weapon, from heavy machine-guns such as the Maxim to self-loading pistols. For example, the Colt automatic has a recoiling barrel which is locked with a slide (or breech lock) during an initial recoil of $\frac{1}{8}$-inch. Then the slide disengages from the barrel and continues to the rear, extracting the fired cartridge—an example of the short-recoil system.

In the long-recoil system as used in Remington autoloading shotguns and rifles, barrel and bolt go back all the way together, compressing their respective springs. The barrel is released from the bolt as it returns forward, while the bolt is held back by a catch, and prevents the empty case from moving forward with the barrel.

Gas Actuation

If gas is drawn off from an opening in the barrel near the breech, the pressure is too great to be harnessed with safety. For this reason the gas port is arranged as far forward as practicable. The gas either impinges on the piston and blows it back in an *impinging-gas arm*, or is admitted to a gas cylinder in an *expanding-gas arm*. The former arrangement is simpler than the latter, but has a much rougher performance.

Firing Pins

Firing pins vary in size and shape according to the type of cartridge and the pressure developed. For a central-fire cartridge the firing pin should have a hemispherical end of 0·073 to 0·075 inch diameter projecting 0·055 inch beyond the face of the breech. It should be smooth, and not sharp in any way, for it must not puncture the primer. For a rim-fire cartridge the best firing pin is flat-ended producing a rectangular impression right on the rim of the cartridge, and not away from the rim towards the centre. The flat end should be rounded at the edges, so as not to cut the cartridge, and should be of that degree of narrowness which produces adequate impression without penetration. A satisfactory width is 0·05 inch. The depth of depression made on the rim of a rim-fire cartridge should be at least 0·02, and never less than 0·015 inch, to ensure satisfactory ignition.

Too weak a main-spring or too short a stroke of firing pin may cause misfire in extreme cases, or inaccuracy due to irregular firing of cartridges. The time taken for the firing pin to fall is also important for accuracy, for the shorter the time between the release of the trigger and the bullet leaving the muzzle, the less will be the effect of movement of the rifle during this instant.

Triggers

Triggers are made either in one piece with the sear, as in the Martini action, or they press on the sear arm, the sear being a separate component, as in most bolt-action rifles. The trigger has its trigger-spring, which exerts part of the trigger's resistance to the pull of the finger. The greater part of this resistance is, however, dependent on the angle made by the *bent* of the tumbler or cocking-piece to the motion of the sear, and trigger weight is

adjusted by altering this angle slightly by rubbing the surface of the bent with a stone slip. The lightness of trigger pull is limited by considerations of safety in competition and military shooting; but sometimes very light triggers are advantageous for sporting purposes.

A *hair-trigger* is a secondary trigger which is behind the main trigger, and the purpose of which is to make possible the firing of the arm by an extremely light touch on the main trigger. If the main trigger is pulled without the hair-trigger having been pulled first, the arm can be fired in the ordinary way, and the trigger pull is somewhat heavy. If the hair-trigger is pulled first until it clicks, the lock is then set, so that a very light pressure on the main trigger releases the *hair*, which flies up and strikes the sear arm, which in turn disengages the sear and fires the gun. Some hair-triggers incorporate multi-lever mechanisms which are extremely delicate.

If the hair-trigger has been pulled but it is decided not to fire the shot, the mechanism can be uncocked by holding back the hair-trigger, slightly depressing the main trigger so as to permit the hair-trigger to disengage, and then releasing the latter very slowly. Precautions must be taken against accidentally firing the arm, which should be pointed in a safe direction.

There are also single-trigger mechanisms in which the hair-trigger is pushed forward to set it.

Safeties

The safety catch of a double gun is sometimes designed merely to lock the trigger, preventing it from pressing against the sear tail: it does not prevent the gun from being jarred off. Such a safety catch is an added precaution to careful handling, but should not be relied upon to prevent the gun from being fired by a jolt. Double guns and rifles can be so constructed that the safety catch automatically goes on when the gun is cocked. This is advantageous in a shotgun, but is not advisable for a double-barrelled rifle used for shooting dangerous game.

The safety catches of several designs of rifle are positive, in that they lift the bent off the sear, taking the weight of the main-spring. The trigger can then be pulled without producing any effect, and the firing pin cannot fall for as long as the rifle is " on safe ".

Intercepting safeties (see Chapter XI) are provided on side lock guns and double rifles, and somewhat similar mechanisms are incorporated in some makes of revolver.

Hammer guns and rifles with external hammers are usually rendered safe by placing them in half cock, which position they adopt automatically on being loaded. What happens when the gun goes into half cock is that the sear engages in a bent which is extra deep or set at such an angle that the trigger cannot be pulled or is very heavy. Also the hammer when at half cock is not sufficiently lifted to fire the cartridge should it accidentally fall, and the position of half cock holds the hammer off the firing pin, so that the cartridge cannot be fired by an accidental blow on the back of the hammer.

Such hammer guns have to be cocked by lifting the hammer with the thumb, and can be uncocked by cautiously taking the weight of the hammer and lowering in into half cock while the trigger is released. In firing a hammer gun the sear comes out of the bent and, as the trigger remains pressed, the second bent of the half cock position, which is set back slightly, passes the sear without catching on it.

CHAPTER VIII

METALLIC OR IRON SIGHTS

A GUN can be brought to the shoulder, pointed in the direction of aim and fired, and in this way a large object can be hit with a single bullet or a smaller one with a charge of spread shot. A shotgun is used in this manner, and birds are hit fairly consistently by a charge of shot which spreads over a circle of about 60 inches at 40 yards, the greater part of the charge being within a 30-inch circle at that distance. The sportsman using a shotgun can therefore afford to make an error of aim of about one half degree of angle without missing.

This degree of error is not permissible when a single bullet is fired at a small distant target. To be sure of bringing down a deer at 200 yards, error should not exceed two or three minutes of angle, or less than a tenth of the error permissible with a shotgun. This accuracy, made mechanically possible by the rifling of the rifle barrel, cannot be fully utilised without the aid of sights.

When a backsight and a foresight, which are set truly in line with the line at which the bullet leaves the barrel, are so placed relative to the eye of the shooter that the foresight is centred in the backsight and is on, or just under, the point desired to be hit, a very small inaccuracy of aim can be detected and, subject to the shooter's ability to hold the rifle steady, corrected. The amount of error that can be appreciated by an experienced shot is so small that ordinary target sights are made adjustable to quarter minutes of angle, an adjustment of a quarter minute being approximately the equivalent of a change of aim of ¼ inch on a target at a range of 100 yards.

Sights are classified as *metallic* or *iron* sights if they are plain sights not incorporating lenses, as opposed to *telescopic* or *optical* sights, which have two or more lenses capable of being focused to form an image.

Metallic sights are again classified into *open* sights and *peep* or *aperture* sights. Both of these types were early inventions, the earliest rifle-sights being simple open sights consisting of a bead or blade foresight and a notch backsight. This is perhaps the

crudest form of sight, but is still has its uses, for the wide V-notch open backsight is the standard sight fitted on big-game rifles, unless otherwise ordered, being popular with shooters of dangerous game because it allows a much quicker aim than other types of open sight and gives a fair view of the target. Deep, narrow V-notches are unsuitable, for they hide too much of the animal, and have to be used with a small bead foresight which is hard to see.

Open Sights

The foresight of open sights is placed near the muzzle of the rifle; the backsight farther back on the barrel, but not too near the eye, because it has to be kept reasonably well in focus to be seen sufficiently clearly for sighting. In sighting, the blade is centred in the notch, with its top level with the shoulders of the notch, and if aimed at the bull of a target, a 6 *o'clock* aim is taken—*i.e.* the top of the blade is just under the bull at what would be the position of 6 o'clock if the bull were the face of a clock. In sporting shooting the blade is held on the point of aim at the distance for which the rifle is sighted or, unless the sights are adjustable, above or below for longer or shorter ranges respectively. A bead rests in the V, the whole just seen.

The open V backsight is not good for a very accurate aim because the aim varies considerably with the position and strength of the light. A lateral light shining on the backsight causes an error to one side, and variation in intensity of light alters elevation. Military rifles have been fitted with flat top backsights having small U-shaped or semi-circular notches. These expose more of the foreground than a wide V, and permit more accurate aim if the light is good and time is available for a carefully aimed shot, but they are not suitable for big-game rifles because they are slow to align and tend to blur, particularly in a bad light.

With all open sights of these kinds the rifleman has to learn the correct relative positions of backsight, foresight and target, and, in target shooting, the amount of *white* to allow under the bull.

Foresights used with notch backsights are best black-coloured, parallel-sided, flat-top posts, or blades, or round beads if used against a light background. But, as in hunting as against target shooting, the background may be dark, a coloured bead is often

of more general utility. Red-coloured, "gold" and "ivory" sights are popular, for they show up well against almost any background. The so-called gold sights are in fact made of copper alloy, a small piece of which is let into or fixed to the sight. All bead sights should be flat surfaced, not rounded; for when a bead is rounded the light shines on one side and causes an error of aim away from the light.

Pistol Sights

Pistol sights are almost invariably open sights, and most frequently consist of what are generally known as Patridge sights—*i.e.* a flat-topped post foresight and rectangular notch backsight. The Patridge sight is intended to be used by lining the top of the post with the shoulders of the notch, and with an even amount of daylight showing through the notch on each side of the post: it is very good for target-shooting.

Beads have been used for pistol foresights, but now the blade is universal. Pistols intended for use in an emergency have fixed blades which are part of the barrel and can be adjusted only by filing the top to raise the point of aim, or one side to give lateral correction.

It should be remembered when filing fixed sights that filing off the top of the foresight raises the shot, filing the side of the foresight moves the shot in the direction of the side that is filed, and filing the inside of the backsight notch also moves the shot in the direction of the side that is filed. Where the backsight of a revolver is a notch in the top of the frame, the only way in which elevation can be lowered is by fixing a piece on the foresight so as to lengthen it. Target pistols have adjustable backsights where permitted by the rules of competition.

The ideal foresight blade for target shooting is one with a vertical face at the back which appears black against the target. This type, however, is liable to catch when drawn from the holster or pocket, and is therefore not desirable on a pistol intended to be used in an emergency. The type then preferred is a blade which is semi-circular when viewed from the side; but this, while it has no corners to catch, is not ideal for accurate shooting because the varying position at which the light catches the curved upper surface makes judgment of elevation difficult.

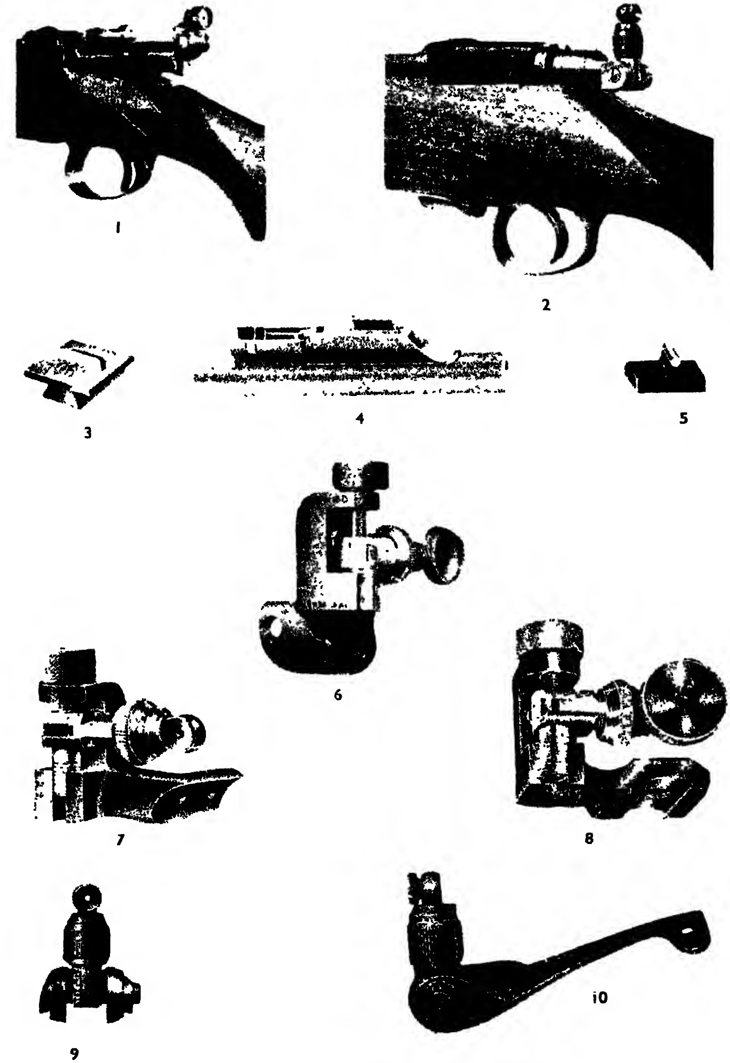


FIG. 12.—SIGHTS FOR SPORTING RIFLES.

1. Holland & Holland Aperture Backsight for Mounting on Bolt Sleeve. 2. Parker-Hale Aperture Backsight mounted on bolt of Westley Richards Rifle. 3. Parker Hale Stainless Steel Bead Foresight for Lee-Enfield. 4. Westley Richards Sporting Bead Foresight with Protector. 5. Parker Hale Bead Foresight. 6. Parker Hale "Sportarget" Aperture Backsight for Mossberg Rifle. 7. Parker-Hale "Sportarget" Aperture Backsight for ·22 Bolt Action Rifle. 8. Parker-Hale "Sportarget" Aperture Backsight for ·22 Mauser Rifle. 9 and 10. Parker Hale "Sportarget" Aperture Backsight for Martini Rifle.

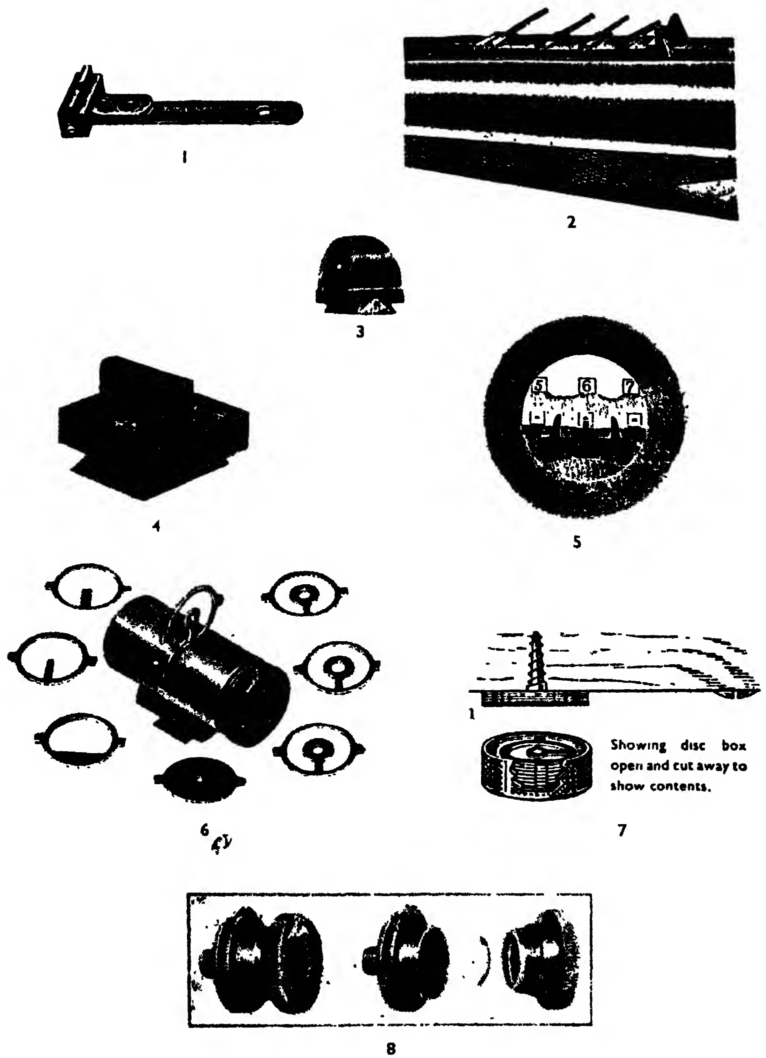


FIG. 13.—SIGHTS AND COMPONENTS.

1. Webley Screw Adjustable Pistol Sight. 2. Flick-up Leaf Sight as Provided on Big Game Rifles. 3. Parker-Hale Watson Type Sporting Foresight. 4. Parker-Hale Service Rifle Foresight. 5. Service Rifle Foresight as Viewed Through Aperture Backsight. 6. Parker-Hale Target Foresight with Interchangeable Discs. 7. Parker-Hale Box Holding Foresight Discs. 8. Parker-Hale Backsight Attachment with Six-hole Variable Aperture and Lens Holder.

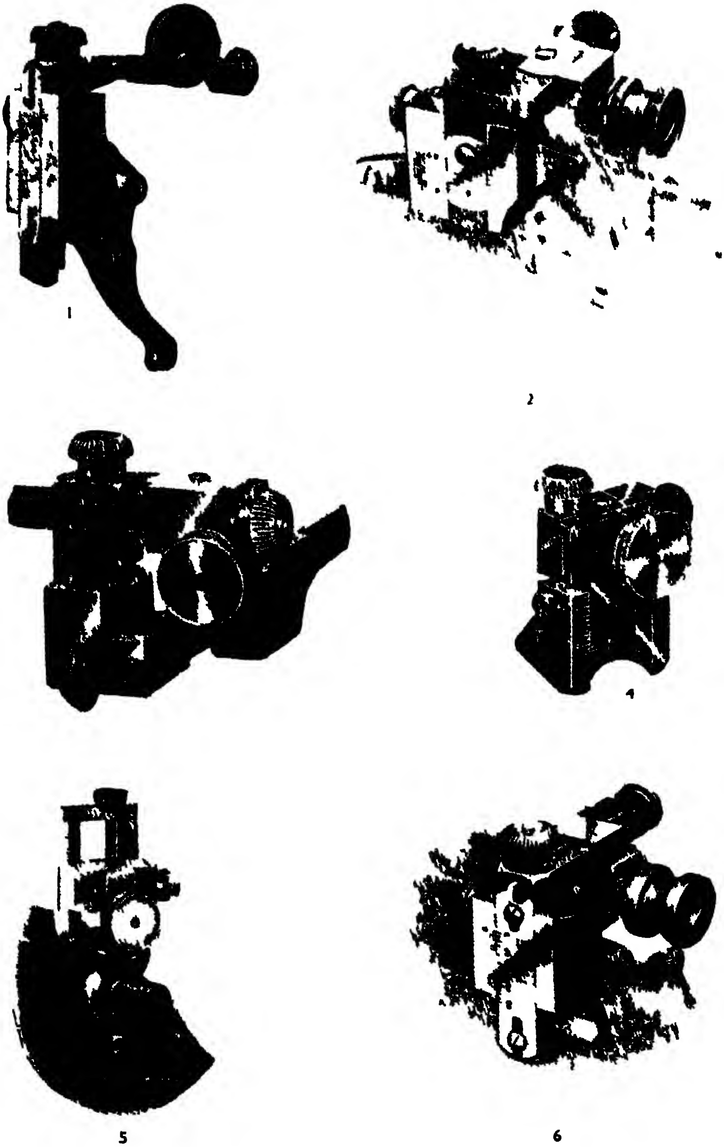


FIG. 14. PARKER HALE TARGET APERTURE BACKSIGHTS

1. For S.M.L.E. No. 1 Rifle. 2. For Rifle No. 4 Mark I. 3. For Winchester '52. 4. For B.S.A. Martini Target Rifles Nos. 8, 12, 13 and 12/15. 5. Folding Model for Rifle No. 4 Mark I. 6. For P. 14 Rifle.

F

Methods of Fixing Sights to Rifle

The foresights of most cheap and many other rifles are fixed to the barrel by a dovetail which is driven into a dovetail groove cut in the top of the barrel. Lateral adjustment of simple sights is effected by driving the sight to left or right with a hammer, and a piece of soft metal interposed to save damage.

The dovetail and groove are slightly tapered, and the dovetail is driven in from the left as viewed from the back of the rifle. This is a point to be borne in mind, for should the sight need to be driven out, it should be driven from right to left, as driving it in the opposite direction would damage the groove.

This arrangement has been in use for a very long time, and is perpetuated in some rifles of recent design, but it is not altogether satisfactory, for a dovetailed sight, unless particularly tight in its groove, can get knocked out of position; and the exact fitting of a sight so that it is tight enough for service and yet capable of adjustment needs careful handwork.

Open backsights are often fixed in the same manner, but being at the rear end of the barrel, where less likely to get knocked and where the large diameter of the barrel permits a longer dovetail, they can be considered more satisfactory than foresights similarly secured. Moreover, some rifles have a special wide diameter band turned on the barrel to permit secure dovetailing of the backsight.

Soldered-on ramp foresights are more attractive in appearance and are of more practical utility except when, as in some instances, the bead or blade of the sight is dovetailed into the ramp and unprotected. Ramp foresights are made out of one piece of metal, and consist of a solid block ramp sloping up from the barrel towards the muzzle and, sometimes, a tube or band which passes round the barrel. The band is carefully made so as to tightly fit on the barrel, and is sweated in position.

Better than a dovetail cut from side to side across the ramp is a dovetail formed longitudinally in the top of the ramp into which a sight blade is easily slid and pinned in position with a screw or spring and stud. A spare blade can then be carried, in a trap in the butt plate or in the pistol grip cap.

Ramp foresights can also be fitted with protectors in the form of spring-steel split tubes slipped into grooves cut in the sides of

the ramp. The Westley Richards foresight (see Fig. 12), which has a hinged protector, is particularly useful for shooting in wooded country; for the rifle can be carried with the sight covered by the protector, which cannot come off, but can be flicked over with the finger whenever the foresight has to be used.

Adjustment

Very crude open sights as provided on cheap air rifles or on the cheapest rifles made abroad have no means of adjustment other than the lateral adjustment that can be made by driving the sights through their dovetail wedges. All other sights are adjustable for elevation, and modern sights of high quality are capable of fine adjustment for both elevation and *windage—i.e.* lateral adjustment.

Adjustment of the V-notch backsight for elevation by the provision of a number of flick-up folding leaves, each being a similar backsight but with different elevation, is an ancient invention, having been in use for at least three hundred and seventy years. The flick-up hinged leaf is more robust than perhaps any other adjustable sight. It does not, however, satisfy all sportsmen, and it is of little use to anyone else.

Other types of adjustable backsights that have been used include a sight mounted on a spring which is wedged up from the barrel by a stepped wedge (still fitted to cheap rifles), also a sight which slides up and down in a frame arranged to be flicked up when wanted. Some of the latter type have ranges marked on in yards or metres, but these ranges can be considered the crudest estimate except where a sight has been calibrated for a particular brand of ammunition.

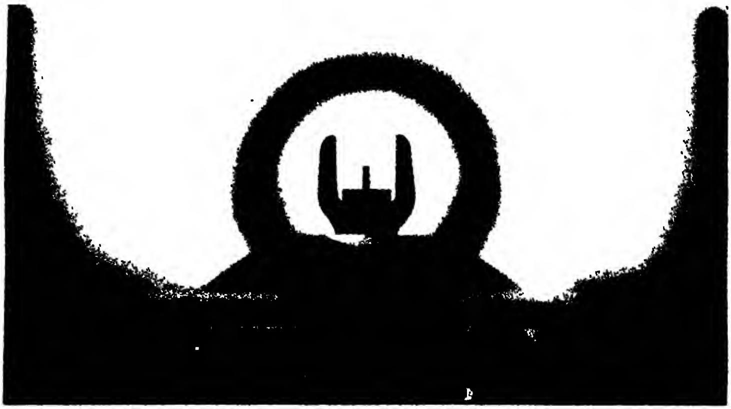
Aperture Sights

The main disadvantages of open sights are that the target, the foresight, the backsight and the shooter's eye have to be manœuvred into line and the eye focused so as to get a reasonably clear picture of the target and both sights. The use of an *aperture sight* (also called a *peep sight* or *orthoptic sight*) greatly simplifies sighting in two ways, for the small aperture of the backsight serves as an iris diaphragm which sharpens the picture of the foresight, making focusing of the eye much less difficult. Also the eye more easily, and with less conscious effort on the

part of the shooter, centres itself in the small opening of the backsight.

It is said that the eye automatically adopts a truly central position and that the shooter cannot help looking right through the middle of the aperture. This is not true: nevertheless, centring is easy—much more so than with an open backsight—and sighting is more rapid.

It might be thought that the small aperture of a peep sight would cut down light to the extent of making shooting in a bad light difficult. But in practice it is found that unless much too



[*By courtesy of Messrs. Alex. Martin, Ltd.*

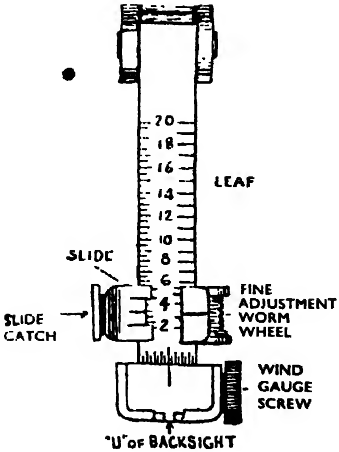
FIG. 15.—FORESIGHT OF MILITARY RIFLE AS SEEN THROUGH APERTURE BACKSIGHT.

small an aperture is used, the peep sight is better in a bad light than the open sight, for when it is very dark an open backsight becomes invisible, whereas the eye can easily find the aperture if the rifle is well fitted to the shooter, and, provided the foresight is visible against the background, a shot can be taken.

A rifle is said to be fitted with aperture sights if the backsight is an aperture sight, for the term applies to the principle of looking *through* an aperture *at* the foresight and target. And this is regardless of the type of foresight used. There are, however, aperture foresights consisting of a ring, which are normally used for small-bore target shooting in conjunction with aperture backsights; and a special type of ring foresight has been devised for game shooting.

FIG. 16.—SHOWING HOW OPEN SIGHTS OBSCURE THE TARGET.

Shot taken slightly high and too far back.



[*By courtesy of The National Small Bore Rifle Association.*

FIG. 17.—PLAN VIEW OF SERVICE RIFLE (S.M.L.E.) OPEN BACKSIGHT, SHOWING SIGHT SET FOR 325 YARDS RANGE.

As contrasted with open sights, aperture backsights are not fixed on the barrel, for they must be near to the eye. Three positions of fixing determine the design and nomenclature of the sight: these are *action*, *bolt* and *tang-mounting* backsights used according to the design of rifle to which they are fixed.

Sights which mount on the action are generally the most compact, and applicable to the majority of rifles; but they need to vary considerably in design according to the action of the rifle to which they are fitted and the purpose of the rifle. Most modern target backsights fall into this category.

Tang-mounting peep sights are used on sporting rifles with lever actions and any rifles the butts of which are secured to the action by tangs.

Bolt-mounting peep sights are used on some bolt action sporting rifles because of the difficulty of finding anywhere else to fix the sight. The sight is attached either to the cocking-piece —in which case it moves when the rifle is fired—or to the bolt sleeve (see Fig. 12). A sight in this position on a heavy magazine rifle is good for quick, accurate shooting of game. These peep sights for sporting rifles consist of a narrow ring of metal round the aperture, not a pierced plate as is used for a target rifle, for the latter obstructs too much of the view when taking rapid aim.

Target Sights

Nearly all small-bore target shooting is with aperture sights capable of recordable adjustment in quarter minutes of angle. This, in the case of a rifle having a length of, say, 32 inches between sights, means that the backsight must be easily and accurately adjusted by amounts of little more than two-thousandths of an inch; and the rifleman must be capable of making these adjustments without delay or trouble while shooting in practice or competition.

The fine adjustment necessary is secured by elevating the sights with slow screws accurately fitted to prevent backlash. Lateral adjustment is similarly effected. As a rifleman cannot conveniently see his sights when in the shooting position or, in the case of a small-bore range, in the dark, he must be able to make his adjustments by feel, and this requirement is provided for by small ball-bearings and springs which, moving in and out of holes in the knurled screws by which the sights are adjusted, cause a

click which may be heard and felt every time the screws are turned by the amount which produces an adjustment of one quarter minute of angle of the line of sight. Sights provided with this arrangement are known as *quarter-minute click sights*.

In order that when a target rifleman is about to shoot at any particular range and with any particular ammunition he may know the adjustments necessary for him to hit the centre of the target without shooting trial shots, there must be some means of recording sight adjustments. Vernier readings are usual in England, elevation being given in minutes of angle above an assumed zero, while windage is measured in minutes of angle left and right of a zero position which is capable of adjustment.

A useful rule to be kept in mind when adjusting quarter-minute click sights is that adjustment of a minute of angle amounts to a movement of approximately 1 inch on the target at 100 yards and, of course, proportionately a greater or lesser amount, according to the range.

To adjust a target backsight for the first time at a range of, say, 25 yards, a group of shots is fired at the target and the position of its centre observed through the spotting telescope. Now, as a range of 25 yards is one quarter of 100 yards, a minute of angle is the equivalent of only $\frac{1}{4}$ inch on the target, so if the centre of the group is, say, 2 inches below the bull, the backsight has to be raised by turning the knurled screw on the top through thirty-two clicks. Similarly, if the shot were $\frac{1}{2}$ inch to the left, the windage screw would have to be turned eight clicks to the right.

The backsight must be moved in the direction in which the shots have to be moved: to raise the point of aim the backsight must be raised; to move the point of aim to the left the backsight must be moved to the left; and vice versa. These movements are usually (but not always) made as follows: turning the elevation screw clockwise raises the backsight; turning the windage screw clockwise moves the backsight to the right.

Having fired a series of shots at an indoor target at a range of 25 yards and adjusted the sights until the average of a carefully shot group of ten shots is in the centre of the bull, the rifle may be considered adjusted for zero—*i.e.* sighted up for 25 yards for the particular ammunition used. If the sight is of a kind which permits such adjustment, the windage scale should then be set so as to read zero without any alteration to the position of the

sight. If this is not possible, the reading of the windage should be recorded. The elevation reading on the vernier or micrometer scale should also be recorded in a book kept for the purpose, information being included in the following manner.

Indoors
25 yards
B.S.A. 12/15 P.66352
Elevation 11¼ minutes
Windage adjusted to zero
Ammunition I.C.I. Mark I

25 yards
B.S.A. 12/15 P.66352
Elevation 11¼ minutes
Windage ¼ minute to the left
Ammunition I.C.I. Standard

50 yards
B.S.A. 12/15 P.66352
Elevation 13¾ minutes
Windage ¾ minute to the right
Ammunition I.C.I. Standard

100 yards
B.S.A. 12/15 P.66352
Elevation 20¾ minutes
Windage 1¼ minutes to the right
Ammunition I.C.I. Standard

Open-air shooting at Petersham. Variable wind blowing across range.

Indoors
25 yards
B.S.A. 12/15 P.66352
Elevation 11 minutes
Windage zero
Ammunition I.C.I. Rifle Club

How to Read the Vernier

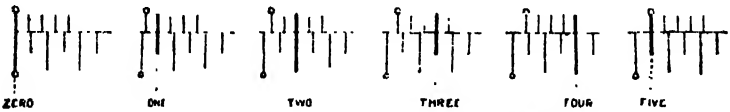
The vernier scale is a very simple but effective contrivance for reading linear measurements to hundredths of an inch or less. A number of types of vernier are used on surveying and other scientific instruments: those used for rifle sights are normally a *direct-reading* vernier for measuring elevation and the *double direct-reading* vernier for measuring windage.

The main scale of elevation is divided into intervals of approximately five minutes. Sliding parallel with the main scale is the vernier, which has five divisions in all, each of which is four-fifths of a division on the main scale. If the zero mark of the vernier is

exactly opposite, say, the ten mark on the main scale, the elevation of the sight is ten minutes. If, however, the zero mark of the vernier is slightly above the ten mark of the main scale but the next mark above the zero of the vernier is in line with a line on the main scale, the reading is eleven minutes. If two marks up from zero is in line with a mark on the main scale, the reading is twelve minutes—and so on, up to fourteen minutes, when the last line of the vernier will be in line with a line on the main scale. Further elevation brings the zero of the vernier opposite the fifteen mark of the main scale (see Fig. 18).

The readings so obtained are in whole minutes. To find readings to a quarter of a minute, click back until a line on the vernier corresponds with a line on the main scale, counting the clicks.

The double direct-reading vernier used for windage has six



[*By courtesy of The National Small Bore Rifle Association.*

FIG. 18.—ILLUSTRATING THE READING OF A DIRECT VERNIER.

instead of five divisions, the two end divisions both being marked zero so that the scale may be read in either direction, left or right. When windage is at zero the two end readings are opposite to two zero markings on the main scale.

It is possible that verniers somewhat different from those above described may be found on some makes of sights, but the principles of all verniers are sufficiently alike to be easily understood after a little study.

MICROMETER SIGHTS

Micrometer adjustments are used on scientific instruments when the accuracy required is such that a vernier would be unduly cumbersome and difficult to read. Rifle sights do not fall into this category, and for them verniers are adequate and generally preferred by British sight manufacturers. American riflemen and manufacturers appear to prefer micrometer adjustments for target and some sporting sights.

Size of Aperture

There is a right size of aperture to use according to the individual and the light. Apertures can be changed by screwing out the eyepiece and replacing with one having a different-size

(By courtesy of The National Small Bore Rifle Association

Fig. 19.—Bull's Eye of Target Seen over Open Military Sights.

hole, but the Parker Hale six-hole eyepiece contains a diaphragm which can be rotated to bring any one of six different sized apertures into position, the range of sizes being as follows:

0·03 inch	0·06 inch
0·04 ,,	0·07 ,,
0·05 ,,	0·08 ,,

To find the right size of orifice, commence with the largest change down to the next smallest and so on, until there is a noticeable reduction of light, then go back one. This should give the best definition.

For military and sporting purposes large apertures are desirable, because they cut down the light to a less extent than do the small apertures preferred for small-bore target shooting.

The *Textbook of Small Arms* gives an average size of backsight aperture of 0·06 inch for military rifle-target shooting, and at least 0·08 for shooting in the field. Sporting peep sights usually consist of just a thick ring, so as to make it easier for the eye to find its position, but it is considered that this arrangement is unsuitable for a military rifle because of the danger of a soldier, in excitement, not remembering to look through the aperture at all. Also it does not assist in sharpening definition of both target and foresight, as does an aperture in a plate or disc that obscures the field outside the aperture.

Target Foresights

While it is possible to use any kind of foresight in conjunction with an aperture backsight, bead foresights are not too suitable for target shooting. Blade foresights can be and are used on service rifles in practice and in competition, regardless of the type

of backsight permitted. During competition shooting they should be blackened with sight black, which is a suspension of carbon black in alcohol. This quickly dries on the sight, leaving a dull black surface which does not reflect the light but which can be removed by wiping with a rag.

For small-bore target shooting an aperture foresight is almost invariably used. This consists of a diaphragm of blackened metal stamped to the form of a ring supported on a post. The whole is enclosed in a *tunnel* foresight which is a tube, the purpose of which is to prevent direct rays of light from falling on the sight. The diaphragms are easily removable so that they may be interchangeable with others of different sized aperture. (See Fig. 13.)

Generally it is considered that foresight apertures should be just large enough for the bull to appear in the aperture as a black spot encircled by a faint white ring. But some shooters prefer a larger aperture through which the bull appears as a dot with quite a lot of white all around it. When aim is taken, the band of white should be even all round.

The blade or post foresight insert is used in place of an aperture when shooting at "tin-hat" targets, and is often preferred by service rifle shooters when practising with the small-bore rifle in the winter season.

Another form of aperture foresight is an insert of transparent coloured celluloid with a small hole in the centre. The whole target can be seen through this, but the bull, being in the centre of the hole, is surrounded by a white ring, whereas the rest of the target is the colour of the transparent insert. The size of the hole can be reamed to larger diameter if desired.

Shade for Left Eye

The fixing of a shade so that the left eye need not be kept closed during shooting reduces eye-strain, and is very helpful to some shooters. Such an eye-shade for use with the Parker Hale backsight, shown in Fig. 14, can be made from a piece of leather $\frac{3}{16}$ inch thick and 5 inches long, dyed black, and cut to the shape shown in Fig. 84. The slot, just a little less than $\frac{3}{8}$ inch wide, fits over the rectangular projection of the sight just in front of the eyepiece.

Orthoptics

Orthoptics are opaque discs which can be used like an eyeglass or in place of one lens of a pair of spectacles, and have

small perforations through which the shooter looks when firing with a pistol. The effect of looking through a pinhole is to sharpen the outline of foresight, backsight and target so that all appear reasonably clear at the same time.

Elevation

Tables 17 and 18 give the average rises between ranges of the three service rifles using the Mark VII cartridge with 174-grain pointed bullet and having a muzzle velocity of 2,400 f.p.s.

Table 17

S.M.L.E. (No. 1) and No. 4 Mk. I Rifles

From, yds.	To:									
	300	400	500	600	700	800	900	1,000	1,100	1,200
200	3	6½	11	16	21½	27½	34½	42½	51½	61½
300	—	3½	8	13	18½	24½	31½	39½	48½	58½
400	—	—	4½	9½	15	21	28	36	45	55
500	—	—	—	5	10½	16½	23½	31½	40½	50½
600	—	—	—	—	5½	11½	18½	26½	35½	45½
700	—	—	—	—	—	6	13	21	30	40
800	—	—	—	—	—	—	7	15	24	34
900	—	—	—	—	—	—	—	8	17	27
1,000	—	—	—	—	—	—	—	—	9	19
1,100	—	—	—	—	—	—	—	—	—	10

Table 18

Enfield Patt. '14 (No. 3) Rifle

From, yds.	To:									
	300	400	500	600	700	800	900	1,000	1,100	1,200
200	3	6½	11	16½	22½	29½	37½	46½	57	68½
300	—	3½	8	13½	19½	26½	34½	43½	54	65½
400	—	—	4½	10	16	23	31	40	50½	62
500	—	—	—	5½	11½	18½	26½	35½	46	57½
600	—	—	—	—	5	13	21	30	40½	52
700	—	—	—	—	—	7	15	24	34½	46
800	—	—	—	—	—	—	8	17	27½	39
900	—	—	—	—	—	—	—	9	19½	31
1,000	—	—	—	—	—	—	—	—	10½	22
1,100	—	—	—	—	—	—	—	—	—	11½

Example.—To find the rise from 500 yards to 900 yards, take the extreme left-hand column and find 500 yards: move to the right until directly under the vertical column headed 900 yards. The number shown denotes the rise in minutes. Each minute = two clicks.

CHAPTER IX

TELESCOPIC SIGHTS

THE chief advantage of a telescopic sight is that it does away with the necessity of trying to see clearly at the same time the rifle-sights and target, which, without optical aid, cannot all be sharply in focus. In a telescopic sight the reticle, which is the equivalent of a foresight, is optically brought into sharp focus with the target, so that the shooter, without any eye-strain whatsoever, merely has to bring the reticle on to the point of aim where he sees it clearly superimposed.

The second advantage of a telescopic sight is the increase of definition, and sometimes illumination, which makes possible shots that otherwise could not be taken in an indifferent light.

It has often been said that telescopic sights are too vulnerable for practical shooting, particularly in battle. But this has been disproved, for big-game hunters on both sides of the Atlantic have found that a properly mounted big game telescope will stand quite a lot of knocking about without getting out of adjustment or being severely damaged.

OPTICS

The simplest form of telescope consists of a convex *object lens* which forms an image of a distant object at its focal length, together with an *eye-lens* which, if also convex, can be focused on the image produced by the object glass in such a manner that it passes on parallel rays of light which the lens of the eye focuses on the retina, producing an image. Such a telescope, consisting of two convex lenses, is used for surveying instruments and astronomical telescopes, but is not suitable for spotting telescopes or telescopic sights, because it shows the image of the target upside down.

This is corrected in three ways. Firstly, in the Galilean telescope, the principle of which is involved in *optical sights* (which will be described later), a concave lens, which does not invert the image, is used in the eyepiece. But most *terrestrial* telescopes, including spotting telescopes and telescopic sights,

have, between the object glass and the eyepiece, a third lens which erects the inverted image. The third method of erecting the image is to use prisms as in prismatic binoculars or prismatic spotting telescopes. These have the advantage of shortening the telescope.

While one may speak of there being two or three lenses in a telescope, there may, in fact, be more; for in addition to focusing, erecting and magnifying the image of a distant object, distortion and the prevention of coloured halos around light objects have to be avoided.

The qualities of a telescope are magnification, illumination or light collection, breadth of field, resolution of detail, freedom from distortion of image, and freedom from chromatic or halo formation. Anyone not familiar with telescopes or optics generally naturally looks for magnification without regard to other qualities. But magnification alone is of little value, for unless the object-lens is of sufficient size to resolve the image, definition reduces as "empty magnification" increases, the image becoming more and more blurred and difficult to see. Furthermore, while a telescope may be quite satisfactory for use on stationary objects in a bright light, many telescopes, including telescopic sights, are wanted for the purposes of improving illumination and of quickly picking up moving objects.

The qualities of freedom from distortion of the image and freedom from excessive halo formation are necessary to all good telescopes. The remaining qualities mentioned above are matters of design which have to be sacrificed one for another in an acceptable compromise, for they are not all compatible. Moreover, a telescopic sight needs to have the property not required of other terrestrial telescopes, that there must be considerable *eye relief*—*i.e.* it should be possible for the eye to be held several inches from the eye-lens.

A large objective glass improves resolution of detail and increases illumination, but it makes focusing difficult. A large ocular lens increases the field of view and increases the eye relief, but tends to make the eye position critical. A high magnification reduces illumination, eye relief and the breadth of the field of view, and makes focus critical. Thus it will be seen that a telescope, perfect in every respect, is impracticable. One quality must be sacrificed for the sake of another, and therefore, in the designing

FIG. 20.—TELESCOPIC SIGHTS.

1. Ottway. 2. Aldis. 3. Converted Gunsight. 4. Martin Barr & Stroud. 5. Converted Military Rifle-sight. *Right:* "X-Finder" Target Sight.

of a telescopic sight, the type of shooting for which it is to be mainly used must first be considered. It has also to be taken into account that in the attaining of high magnification and definition, light collection, etc., at the same time, the instrument becomes very heavy and costly.

A telescopic sight, like a surveying instrument, must have a *reticle* or *graticule* to indicate when it is on the mark. Otherwise, while it may serve as a telescope, it is not a rifle-sight.

The reticle or graticule may consist of two cross wires (which may be obtained in various degrees of fineness), a pinhead spot, a post or arrangement of posts, or a combination of wires, spot or posts. When the telescope is properly adjusted the reticle is in exact focus with the target and there is no *parallax—i.e.* if the rifle is placed in a mechanical rest and the eye moved from side to side, the reticle remains in the same position on the target. Telescopic sights vary in the adjustments that are possible, and while in many it is possible to correct the focus of the reticle, parallax, if present at ranges that matter, is usually a matter for correction by the maker.

Mounting

Telescopic sights are difficult to mount, for they are heavy, and their inertia resists the shock of recoil, putting a great load on the mounts, which have to be strong enough not only to withstand the load without breakage, but also to maintain the sight in adjustment.

Some sights can be taken off the rifle by undoing the thumb-screws, which release the grip on a dovetail, which is either part of the rifle or fixed to the rifle by screws, soldering or brazing. Others are fixed direct on to the rifle with screws. If a rifle already has a dovetail of the right size to connect with the mounts of the 'scope concerned, or, as are some American rifles, is already tapped to receive the screws of suitable sights, mounting is easy; but otherwise it is a difficult job which not every amateur can do properly, for the sight has to be fixed securely, truly in the line of the barrel, vertically above the bore, and at the right distance from the eye.

One method which may have to be used is to rest the barrel of the rifle in machinist's V-blocks on a large surface plate and clamp it in position, after adjusting it for vertical by setting a

square against the side of the action, over Nock's form, or against such other surface as is parallel with, or at right angles to, the vertical axis of the rifle. The dovetail barrel blocks or other 'scope fixtures can then be instrumentally set truly in position with their upper surfaces parallel with the surface and clamped there before the screw-holes are drilled and tapped.

The sight should be set as low as possible, for the line of vision is certain to be higher than that of the ordinary iron sights of the rifle, and the higher it is the more the cheek is taken away from the stock. If the sight cannot be set low, or perhaps in any case, a new cheek-piece may have to be fitted to the stock before the rifle can be held with the proper degree of steadiness, for the full accuracy of a rifle cannot be developed if the stock does not fit the user sufficiently well.

Target Telescopic Sights

Because practically all target shooting with telescopic sights is in the prone position, in which a very steady hold is possible, target telescopic sights are all of high magnification of anything from 6 to 20 power. Generally between these limits, the greater the power, the more accurate the shooting becomes.

A shooter for the first time using a telescopic sight of high power is disconcerted by the way in which it shows up the unsteadiness of his hold, but before long his reaction is to steady his hold more and more, reducing the wobble of the bull until he can score with much greater consistency than previously.

A high-power telescopic sight serves also for spotting if its object-glass is sufficiently large to give good definition, in which case the fact that the shooter does not have to alter his position to look at the target between shots is a great help to him.

In positions other than the prone, very high-power telescopic sights are practically useless, because the large tremors that are unavoidable in the offhand, kneeling and sitting positions are disconcerting. For most game shooting such sights are practically useless because of the narrow field of view and critical adjustment for focus.

A target telescopic sight must have similar adjustments to any other target sight, preferably being capable of "quarter-minute click" elevation and windage. Adjustment is nearly always provided external to the sight, in the mounts, not by internal

adjustment of the reticle. Fig. 22 shows Parker-Hale mounts and the method of mounting a telescopic sight in them. The foremost mount is made to hold the telescope steadily at three points on its circumference, a spring pressure being applied from the top. The rearmost mount has the two micrometer adjustments for elevation and windage, together with a spring buffer which keeps the telescope hard against the adjustment knife-edges. Unless the tube has a stop on it, micrometer mounts permit it to slide forward when the rifle recoils. This relieves the mountings from shock, but means that the tube has to be pulled back after each shot.

Sights for Small Game

When choosing a sight for small game, the range at which the majority of shots will be taken should be considered, together with the quality of the rifle. For use with the ordinary ·22 Long Rifle high-speed cartridge the rifle is best sighted for a range of 65 yards, so as to permit accurate shooting up to about 85 yards. For this range high magnification, with consequently small field of view, is undesirable, and cost may be a major consideration.

Suitable sights for ·22 sporting rifles are converted ex-Government gun-sighting telescopes (see Fig. 20). These gun-sights, which originally had no internal adjustments, are adjusted for elevation by means of a rotating prism, which throws the line of sight at an angle to the axis of the telescope, so that whenever a change of elevation is made, windage has to be re-adjusted. This necessitates the use of a mount capable of lateral adjustment. The field of view is of about 10 yards diameter at 100 yards range, which is ample for sporting purposes. The eye relief is exceptionally long.

The author obtained from a Government surplus shop a piece of mechanism which contained one of these sights in its original condition, without any internal adjustments and with a reticle of a very unsuitable kind. After making a special tool he was able to take the sight to pieces and insert in place of the reticle the point of the finest obtainable embroidery needle (human hair was found to be too coarse). Windage was provided by using Parker-Hale mounts having lateral adjustment, but elevation had to be fixed at the optimum sporting range for the rifle concerned—*i.e.* 60 yards. After the error was found on the range, the necessary

adjustment for elevation was calculated and made by filing the barrel blocks on which the mounts clamped. Then the barrel blocks were soldered and screwed to the barrel. Finally the rifle was again taken to the range and an inner carton scored with the first shot.

The ex-Government telescopic rifle sight illustrated in the same figure has no internal adjustment because it was designed for

FIG. 21.—VIEW THROUGH TELESCOPIC SIGHT, WITH CROSS HAIRS ON AIM EXACTLY AS TAKEN IN FIG. 16.

use under tropical conditions. It can be mounted in Parker–Hale mounts adjustable for windage, and if initially set up for a range of, say, 60 yards, allowance for longer or shorter range can be made by aiming above or below the mark respectively. The magnification is 4 ×. Focusing is by removing a sealed plate and stud and sliding the erector unit. The graticule consists of four lines marked on glass with a clear central space.

A suitable telescopic sight mounted on a rifle with a heavy

accurate barrel and chambered for a high-velocity cartridge of not less power than the ·22 Hornet makes possible the shooting of small game and vermin at surprisingly long ranges. For the Hornet cartridge the rifle should be sighted for 150 yards, giving accurate shooting to at least 180 yards, and for this a telescopic sight of 4 × is about ideal.

For ranges up to 300 yards with high-velocity cartridges, sights of the order of 8 × are desirable, or even as much as 10 × if accurate rifles and very high-velocity cartridges, such as the ·22 Swift, are used. Such cartridges are, however, practically unknown in England. Some target sights can be used for vermin shooting, but the narrow field of view and relatively short depth of focus make those of the higher powers of limited usefulness. A good-quality "varmint" rifle chambered for the Hornet or similar cartridge deserves an expensive 'scope made to suit the purpose for which the rifle is to be used.

It might be thought that big game sights would be suitable for small game rifles, but the low magnification, comparative lack of resolving power, make big game sights unsuitable for shooting small game at long range; also the adjustments of big game sights for elevation and windage are seldom of great accuracy or easily made, for they are intended to be permanent during rough usage and for shooting in which an error of 2 inches or so in 100 yards does not matter.

Big Game Hunting Telescopic Sights

Telescopic sights for big game hunting are always of low magnification of 2 to 3½ power, because high magnification is not necessary, and doing without this otherwise desirable quality makes possible others which are of great importance. A big game 'scope must have a field of view of at least 30 feet diameter at 100 yards range, for otherwise it is extremely difficult to keep rapidly moving game in sight. To allow for shooting at all ranges without having to make adjustment for focus for which no time would be available, focus must be virtually universal. To permit, as is often required in big game hunting, shots to be taken in the half-light, illumination must be good. Low magnification makes all of these possible.

The eye must be held several inches from the sight of a big game rifle to avoid injury by the recoil, for which reason the 'scope must

have an eye relief of several inches. And to allow for shooting up and down hill there should be some latitude of position of the eye from the eyepiece, a distance varying from 1½ to 4½ inches being desirable.

The recoil of big game rifles is violent enough to injure a telescopic sight or its mounts unless they are very strongly made of high-quality materials. Robust construction is also a very desirable attribute for a sight which is to be used in rough country.

SIGHTS OF BRITISH MAKE

The Martin Barr and Stroud sight (see Fig. 20) has a magnification of about 3 diameters and a field of view of 30 feet at 100 yards. The graticule consists of cross wires, and is adjustable for elevation and windage. Focusing is by eyepiece: the eye relief is 4 inches, the weight 10 ounces, and the length 11 inches. This sight has an unusual mount which is shock-absorbing and allows instant detachment and accurate instant replacement of the telescope. It also enables very low fitting. Alternatively, Parker-Hale mounts may be used.

The Ottway telescopic sight is adjustable for elevation by means of a rotating drum on the front end at the top. There is no windage adjustment in the sight itself, but this can be provided by using mounts with lateral adjustment. Focusing is by means of a half-sleeve near the eyepiece. The lenses are hard coated with magnesium fluoride to increase illumination. The following is the specification:

Magnification . . .	3·5 ×
Light transmission . .	75%
Field at 100 yards . .	22·7 feet
Eye relief	3 inches
Diameter of exit pupil .	1·00 inches
Length	9½ inches
Weight	15½ ounces
Diameter of object tube .	1·200 inches
Diameter of eyepiece tube .	1·200 inches
Diameter of centre tube .	0·898 inches
Finish	To match rifle

The Aldis telescopic sight has a pointed post and horizontal wire graticule and is focused by helical half-sleeve which is

firmly controlled by a coin-slotted screw. Elevation is adjusted by drum and windage by rotating prism. The specification is as follows :

Field of view at 100 yards	$12\frac{1}{2}$ yards
Eye relief	$2\frac{1}{2}$ inches
Magnification	$2\frac{3}{4}\times$
Diameter of body tube	1 inch
Weight	16 ounces
Overall length	13 inches
Light gathering power indicated by diameter of object glass	19 m/m

The lenses are all hard coated with magnesium fluoride.

The new "X-FINDER" target telescopic sight has a magnification of $20\times$, a minimum field of 7 feet at 100 yards, and 2 inches eye relief. It incorporates an unusual feature—a spirit-level that can be seen at the bottom of the field of view, or can be made to disappear, and which shows if the rifle is being canted. Focusing is by rotating a central ring, and graduations are provided in order that the focus may be set for any particular range. A locking-sleeve retains adjustment. The mounts are of micrometer type with quarter-minute clicks. Coated lenses are provided at an additional charge.

Care of Sights

For the protection of the lenses of a telescopic sight, two leather caps of the required sizes can be made, connected together by a single strap of sufficient length to just permit them being placed in position. Rotation of one of the caps tightens the strap and keeps them both in place. Detachable sights should be provided with a leather holster, so that they can be carried in safety when not in use.

The lenses of sights should never be wiped with any old cloth to remove moisture or dust, for there is always the danger of scratching them. The correct way to remove dust is with a camel-hair brush. If the lenses must be wiped to remove grease or mist, this should be done only with a clean piece of wash-leather or silk kept for the purpose.

Taking down a telescopic sight is much more difficult than

taking to pieces an ordinary spotting telescope or, for that matter, any other optical instrument, such as a microscope. Most ordinary optical instruments—even prismatic binoculars—can be taken

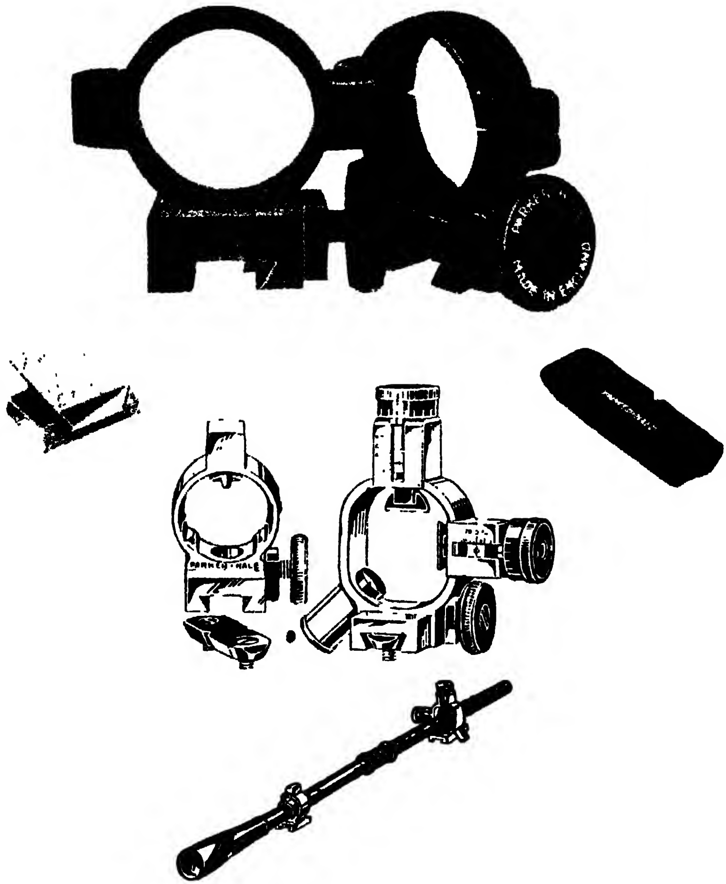


FIG. 22.—*Above*: PARKER HALE DETACHABLE TYPE MOUNTS FOR TELESCOPIC SIGHTS, ALSO BARREL BLOCKS FOR MOUNTING.
Below: PARKER-HALE MOUNTS FOR TARGET TELESCOPIC SIGHTS, ALSO SHOWING SIGHT IN POSITION.

to pieces, cleaned and reassembled by anyone who is reasonably careful and skilful. But this should not be attempted on a telescopic sight, except by those who are experienced and have the necessary tools.

The reason is that, because telescopic sights have to be able to withstand the repeated shocks of rifle recoil, the lenses are fixed firmly in position by collars screwed with fine threads which are turned on the inside of the tube with close tolerances. To remove these requires special tools, and to replace them no small amount of skill.

Optical Sights

The term *optical sights* is applied to the arrangement of two lenses only, one at the muzzle and the other on the breech end of the rifle, or on the butt near the bump. The foremost lens is a convex object glass of long focal length, the rearmost is concave. The principle is, in fact, that of the Galilean telescope, as is incorporated in opera-glasses or toy telescopes. It is simple but effective.

The reticle of the optical sights consists of cross wires, spot or other mark on or near the object glass; or can be the ordinary foresight of the rifle. It appears sufficiently in focus at the same time as the target for use in target shooting.

The concave lens is fitted in an aperture backsight which, if used on a normal rifle, is in the usual position at the back of the receiver. But optical sights are the normal provision for match rifles, and for shooting in the back position the backsight must be mounted on a long, vertical arm fixed near the heel of the butt.

Postscript. A few firms of gunmakers mentioned last summer new patterns of 'scope sight that would soon be available, and since then a number of foreign sights has come on to the market. Of particular interest is a German sight by B. Nickel. This has internal vertical and lateral adjustments, simple focusing and large coated lenses. The specifications of these types are as follows:

Magnification	Light intensity	Field at 100 yards	Length, inches	Weight, oz.	Tube dia. in inches		
					Central	Ocular	Objective
6 ×	56	9 yds	$12\frac{1}{4}$	14	$1\frac{1}{32}$	$1\frac{15}{32}$	$1\frac{7}{8}$
4 ×	81	11 yds	11	$13\frac{1}{2}$	$1\frac{1}{32}$	$1\frac{15}{32}$	$1\frac{17}{32}$
$2\frac{1}{2}$ ×	52	19 yds	$9\frac{1}{4}$	8	$1\frac{1}{32}$	$1\frac{9}{32}$	$1\frac{1}{32}$

A Holland & Holland telescopic sight mount was recently awarded first prize in a War Office competition.

CHAPTER X

SPORTING, TARGET AND MILITARY RIFLES: PISTOLS

THE classification of rifles according to calibre or load is somewhat haphazard, terminology depending on the company in which it is used, for enthusiasts for one kind of shooting are not very often concerned with other branches of the sport.

In the days of black powder, sporting rifles were classed as "large bore", "express" and "miniature", the express being a rifle taking a comparatively high velocity black powder cartridge, first introduced under the name of "Express Train" because the velocity was above the average. The modern term "magnum" denotes the high-velocity rifle using smokeless ammunition.

In 1919 Burrard classified as large bore any rifle of calibre exceeding ·600. (These calibres, which are virtually obsolescent, were described as 8-bore, 10-bore, etc., and not in decimals of an inch.) He classified as medium-bore calibres from ·600 to ·400, and as small-bore all calibres of less than ·400.

John Taylor, in *Big Game and Big Game Rifles*, suggested the adoption of definitions which he said were those generally used in Africa. According to this classification, any rifle of ·450 or larger calibre was described as *large bore*; if not less than ·400, *large medium bore*; and if not less than ·300, *medium bore*. The term *small bore* he applied to *all* rifles of less than ·300 calibre, using the terms *magnum* and *miniature* for rifles with muzzle velocities of 2,500 or more feet per second and muzzle energies of less than 1,500 ft.-lb. respectively.

On the other hand, target riflemen use the term "small-bore" for a rifle not exceeding nominal ·22 calibre, and describe military calibres such as ·300 and ·303 as "full-bore". To them, the term "miniature" is derogatory and in any case inappropriate when used to describe target rifles which weigh as much as, or more than, sporting rifles of "large medium bore".

Other forms of classification are in accordance with use, rifles being termed sporting, target and military rifles. This is very

reasonable, because the design of a rifle depends on the purpose for which it is intended.

Sporting Rifles

Sporting rifles, like military rifles, are designed for practical shooting as opposed to shooting at targets in competition, and as many shots taken in the field of sport or battle are snap shots at near or large objects, the closest accuracy is not always necessary, as for example when shooting big game in thick jungle. On the other hand, some forms of sport involve careful aiming at distant game, the particular instance being American "varmint" shooting, in which small vermin are shot at ranges of 200 yards or more with heavy-barrelled rifles of "gilt-edge" accuracy.

Broadly speaking, it can be said that, on the average, sporting rifles are less accurate than target rifles because the former have to be sufficiently light to be carried long distances without discomfort (except where weight is necessary to overcome recoil), and to have the "shotgun" balance that permits a quick aim being taken; whereas target rifles, having but one purpose, are generally heavy because barrel weight improves mechanical accuracy and steadiness of holding, and their balance is, for the same reason, the reverse of that of a shotgun or sporting rifle. But it must be kept in mind that there are exceptions, target rifles or rifles similar thereto being used in some classes of sport. And it must not for a moment be thought that sporting rifles other than those of the cheaper grades are inferior to target rifles; the reverse is the case, and in workmanship and cost the best sporting rifles exceed all other arms.

Medium game rifles are very similar to military rifles in calibre and, in some instances, general construction: in fact, most military rifles are convertible for game shooting. But the mass-produced military rifle is a very crude weapon compared with big game and medium game rifles. For in the manufacture of sporting rifles, as in that of shotguns, the very finest craftsmanship is expended; and the current models have been evolved over centuries of experiment and experience. Thus the sporting rifle has justly been described as the "King of Weapons".

To allow for the great variety of game that can be shot and for differences of terrain, all manner of calibres and weights of rifles are made incorporating every type of action devised and all sorts

of sights, from the crudest open sights to telescopic sights. Calibres of rifles at present made in England range from the ·600 " elephant gun " to ·22, and in these rifles various loads of low and high velocity ammunition are used.

Hunters intending to shoot more than one kind of game are compelled to carry a number of rifles, which has to be restricted for practical reasons. Anyone shooting in Africa or India could

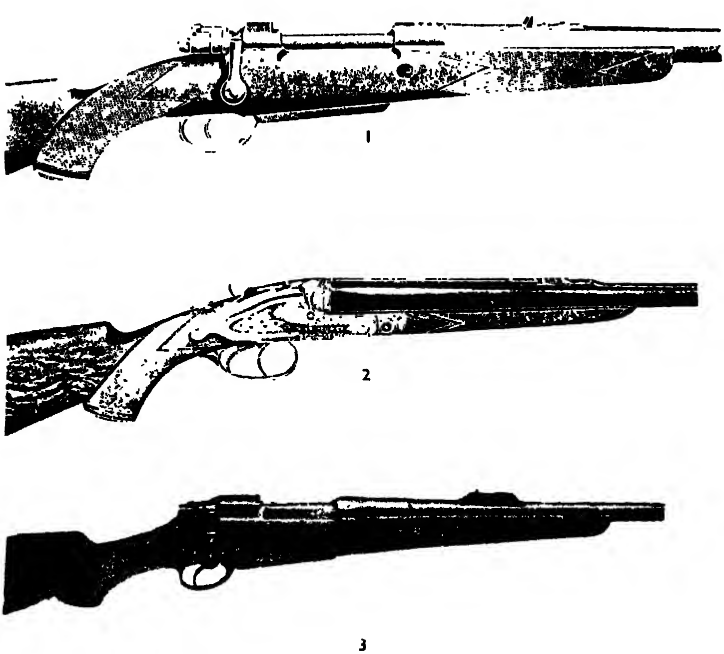


FIG. 23.—1. RIGBY ·416 "BIG GAME" RIFLE. 2. RIGBY BEST QUALITY DOUBLE RIFLE. 3. JEFFERY ·404 OR ·375 MAGNUM RIFLE WITH P.'14 ACTION.

well find use for a heavy big game rifle, a number of medium rifles of double-barrelled and magazine type, and a small-bore for shooting for the pot.

Calibre and load need to be matched to size of game reasonably well. Experienced hunters have recommended time and time again that although it is often possible to bring down a large animal with a small bullet, it is neither good practice nor sportsmanship to use an under-size rifle, for many apparent misses are

Fig. 24.—Holland & Holland Magnum Rifles.

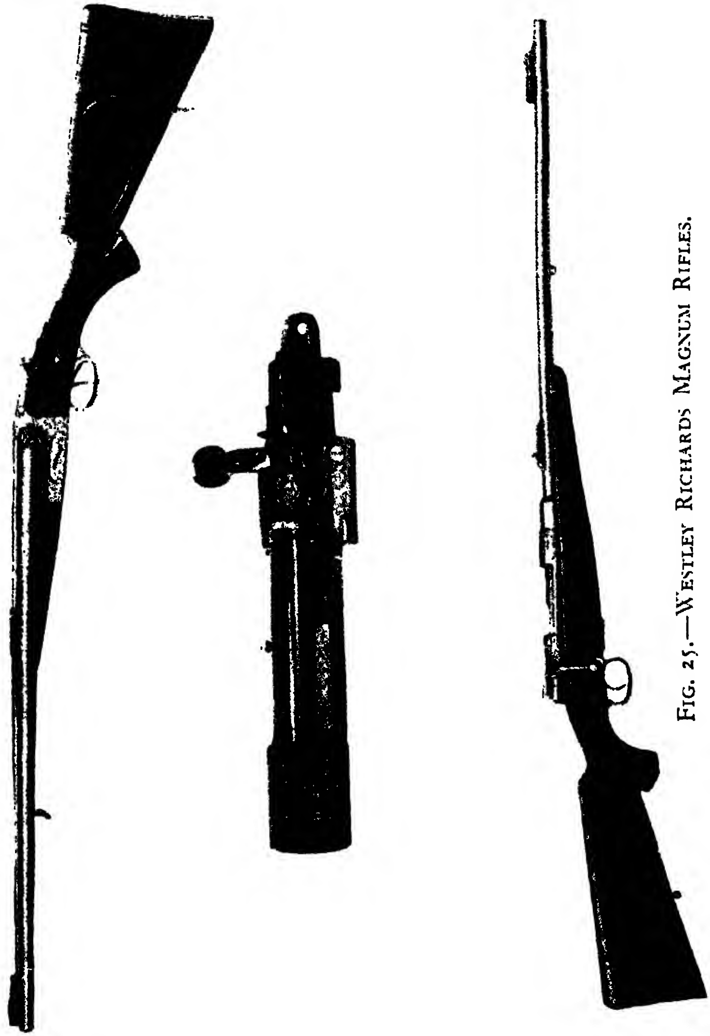


FIG. 25.—WESTLEY RICHARDS MAGNUM RIFLES.

often hits which wound but let the game get away to die in the forest. Conversely, if too powerful a cartridge is used there will be too much damage and waste of meat.

The type of rifle selected depends also on the range at which shots will be taken, this often being influenced by the country. For use in thick bush where dangerous game may be encountered, a heavy calibre double-barrelled rifle is almost essential, for no other rifle has the shotgun balance that permits a quick, accurate shot at close range, and no other rifle permits so rapid a second shot. To these qualities may be added the reliability of a rifle which has a separate lock for each barrel. Also the safety-catch is easier to operate than, for example, that of a Mauser. Short barrels are desirable, for long barrels may catch in the vegetation —another advantage of the double, which normally is of shorter overall length than a magazine rifle. Such a rifle of not less than ·450 bore and used with a solid bullet of not less than 400 grains is ideal for elephant and rhino shooting.

In other respects, the choice between a double and a magazine magnum is a matter of personal preference, and each man should use that in which he has the greatest confidence. The magazine rifle is admittedly of more general use for killing soft-skinned game at ranges upwards of 75 yards in moderately open country, or on occasions when several shots may have to be fired in rapid succession. Also a bolt action has the advantage over a double in that it can be used when very dirty with mud, a condition which can put a double out of action.

For shooting medium game at the long ranges that may be possible in open country, bolt-action repeating rifles are most commonly used, being far less expensive than doubles and capable of greater accuracy.

One of the difficulties in the manufacture of a double-barrelled rifle is making both barrels group together at 100 yards, as is clearly described by John Rigby & Co. (Gunmakers) Ltd. in the following passage :

" Many sportsmen think that all a gunmaker has to do when he builds a double rifle is to set the barrels together so that the two axes of the bore are absolutely parallel, when the rifle will shoot. We only wish that the matter were so simple, but in actual fact the axes must seldom, if ever, be parallel. At first

sight this may seem a very curious fact, but a little thought will soon explain the reason. When the right barrel of a double rifle is discharged the recoil very naturally throws the rifle outwards to the right, and since recoil begins to make itself felt as soon as the bullet begins its passage up the bore, this means that the axis of the right barrel will be pointing to the right of the line of original aim when the bullet actually leaves the muzzle. When the left barrel is fired an identical movement takes place in the opposite direction, *i.e.* out to the left, and so it is not difficult to see that the right barrel tends to throw its bullet to the right and the left to the left. In other words, the two barrels naturally tend to shoot apart. In order to counteract this tendency the barrels of all double rifles are set so that the axes are converging in the direction of the muzzle. The great difficulty in regulating a double is the determination of the correct amount of divergence. This will vary for every individual rifle, as no two barrels behave identically on firing. The vibrations and waves set up in the steel all influence the shooting to a very marked extent. The barrels are first of all set at a slightly convergent angle and are then brazed together at the breech ends. They are then held together at the muzzle with a wedge, and lumps of packing are inserted at various points between the breech and muzzle. The attainment of the best possible shooting from each barrel individually is chiefly dependent on the positions of these pieces of packing, and can only be ascertained by experiment, since no two pairs of barrels require identical treatment. There is no golden rule on which to work, merely experience and the skilful cunning of a master hand. When both barrels have been made to shoot their best independently of each other they are gradually regulated to shoot together by the alteration of the position of the wedge at the muzzle, an extremely delicate and often tedious operation. Sometimes a pair of barrels is spoilt in the process by some unaccountable cause and then all the work has to be begun again with a new pair.

"But this is not all. We have already explained how the barrels naturally shoot apart on account of the recoil. If the weight of the bullet is changed the recoil is also changed and a pair of barrels which may be shooting perfectly together with one weight of bullet, will no longer shoot in accord. A heavier

bullet naturally increases the recoil and tends to make the barrels shoot further apart, while a lighter bullet lessens the recoil when the barrels will shoot somewhat across each other: *i.e.* the right will shoot on the left of the mark, while the left will place its bullets on the right of the mark. A change in velocity has a somewhat similar effect and therefore we do not recommend firing different weights of bullet from the same rifle".

The gunmakers go on to say that nitro powders are sensitive to changes of temperature, and therefore a rifle that has been regulated to shoot perfectly in England will not do so in the great heat of the tropics, and that this has necessitated the adoption of a system of regulation based on a careful study of climatic conditions in all parts of the world.

On the matter of what rifle should be carried as second to a heavy double there is some difference of opinion. John Taylor recommends, as the ideal battery for a sportsman whose funds are limited, a best-quality double ·465 or ·470 non-ejector and a Jeffery ·404 magazine rifle regulated for both standard and high-velocity ammunition, if the sportsman expects to do much elephant hunting; or, if not, a Holland and Holland ·375 magnum.

For medium game lighter calibres are necessary. For the red deer, the largest animal to be stalked in Great Britain, calibres such as Rigby's ·275, the 7 m/m Mauser (·276) for which rifles are made by many British firms, the ·256 Mannlicher Schonauer, and Holland and Holland's ·240 Apex are favoured. During the war many deer were shot with the ·303 military cartridge with pointed bullet (which is unsuitable because it is uncertain on game), and at the present time rifles of ·303 and ·300 calibres, based on the pattern '14 and '17 Enfield rifles respectively, are being produced at very moderate cost. The ·303 cartridge has the advantage of being in good supply and obtainable in all parts of the world, but it is not permitted in most of the Crown Colonies. It is made with round-nose and soft-nose bullets for sporting purposes.

"The Ruffle", in *The Sporting Rifle in Britain*, expresses the following opinion:

"Summing up; for *all* British game your armoury need consist only of two weapons, one for deer and one for the

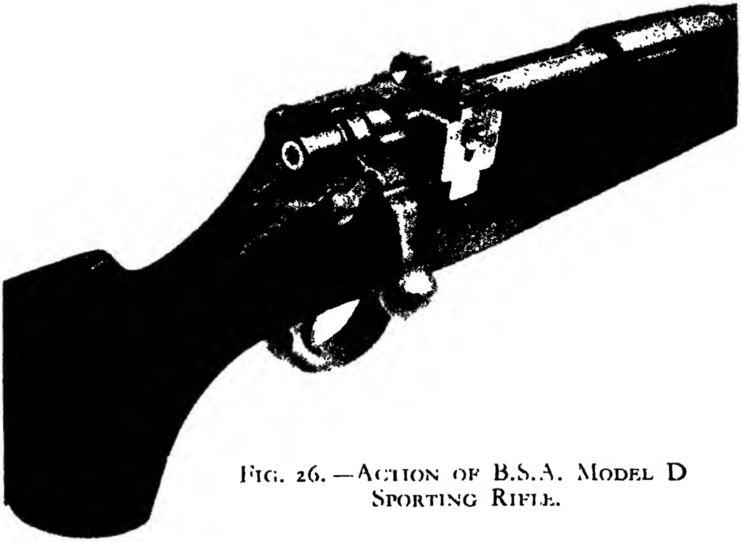


FIG. 26.—ACTION OF B.S.A. MODEL D SPORTING RIFLE.

FIG. 27.—1. B.S.A. SPORTSMAN-FIVE. 2. B.S.A. SPORTING RIFLE MODEL B. 3. PARKER-HALE PATTERN '17 ENFIELD ·30/06 CAL. SPORTER.

lesser fry—ideally, in my opinion, a ·256 Mannlicher * and a ·22 of any good make ".

"Varmint" Rifle

Several cartridges have been developed in America for the shooting of vermin such as the marmot (ground-hog or woodchuck), various species of which are found in different parts of the United States and Canada. For this sport heavy-barrelled rifles fitted with high-magnification telescopic sights are used in conjunction with ·22 high-velocity cartridges which give low trajectory and are of great accuracy. Some of these cartridges are in general production by the leading manufacturers, but there are also, produced commercially or privately made, " wildcat " cartridges which are prepared by necking down or otherwise altering factory cartridges to revised calibre. For example, a bottle-shaped cartridge of more than ·22 calibre may be reduced to take a ·22 bullet and, with its large capacity for powder, produce a very high velocity.

Several of these cartridges are catered for by rifle manufacturers, but in addition the custom gunsmiths, of which there are many in the United States, build to any required calibre or convert by re-barrelling and re-chambering suitable old rifles of American manufacture or imported for this purpose.

There are some dangers attached to altering rifles in this way, for the high-velocity cartridges develop very high pressures, and therefore only sound, particularly strong actions should be converted to take them. On this matter Charles S. Landis, in *Twenty-two Caliber Varmint Rifles*, gives invaluable information and advice.

Most of the high-velocity ·22 cartridges are practically unknown to sportsmen in England, for long-range shooting at vermin is not altogether advisable in a country consisting largely of small fields. Moreover, we have no woodchucks or coyotes to provide interesting shooting, and when we shoot at a rabbit we value the meat too much to be content with blowing it to pieces with the hydraulic shock of a high-velocity bullet. This is one reason why the ·22 rifle used with Short, Long or Long Rifle cartridges is so largely used in this country.

* *I.e.*, The Mannlicher-Schonauer (author).

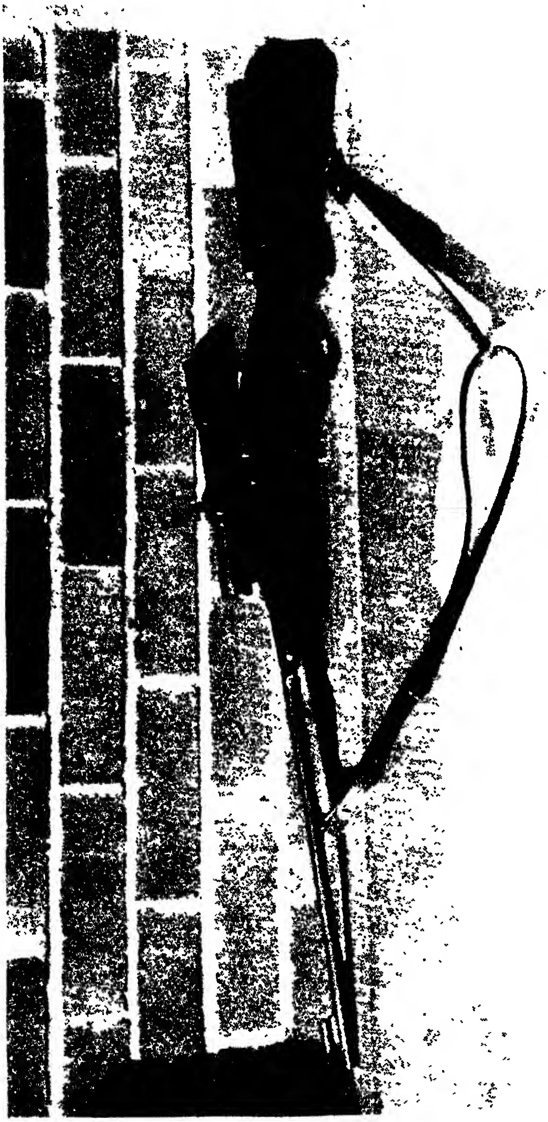


FIG. 28.—THE AUTHOR'S WESTLEY RICHARDS FARQUHARSON-ACTION RIFLE CONVERTED FROM ·303 TO ·22 HORNET AND FITTED WITH 5 × TELESCOPIC SIGHT.

The ·22, however, cannot be fired with safety everywhere because the bullet is likely to ricochet and travel for quite a long distance, and generally sportsmen are recommended to take their shots towards a bank or rabbit-warren that will act as a bullet-stop. The danger is greatly reduced if, in place of an ordinary ·22, the shooter uses a rifle chambered for the ·22 Hornet, for this cartridge, provided it has a soft-nose bullet, does not cause ricochets if aimed at ranges not exceeding 200 yards.

FIG. 29.—*Above:* THE AUTHOR'S BRNO (CZECH) MODEL I ·22 SPORTING RIFLE.

Below: THE AUTHOR'S B.S.A. 12 15 TARGET RIFLE WITH HOME-MADE HAND STOP.

A disadvantage of using a rifle chambered for the Hornet is the cost of ammunition, for Hornet cartridges cost about six times as much as the ordinary ·22 Long Rifle cartridges. Moreover, such a rifle and ammunition are for the keen and expert rifleman only, who delights in taking successful long-range shots at the heads of small game. This weapon in the hands of a man who can hit a rabbit only somewhere in the body would be merely a meat waster and an unnecessary expense. But the sportsman who can afford to use a ·22 rifle that costs as much to fire as a 12-bore gun gains much more satisfaction from it than from an

ordinary ·22. For if it is fitted with a good telescopic sight it can be used with accuracy at three times the range of an ordinary ·22 rifle.

Hornet rifles are not in general production in this country,* but some gunsmiths convert, by re-chambering or re-barrelling, suitable good-quality rifles. The Farquharson is an interesting English action for conversion for the Hornet cartridge. In fact, it is altogether admirable for conversion to small game shooting (see Fig. 28). Although many of these actions have been sent to America they are still not too difficult to find.

Some rook-and-rabbit rifles also are quite suitable for conversion to modern calibres.

Changing from one calibre to another and re-chambering involves either reboring to a larger calibre and rifling, often to a different pitch, or, alternatively, providing a new barrel of the same or smaller bore. The provision of a new barrel, which is the means not only of altering calibre but also of repairing a rifle the barrel or chamber of which has become defective, can mean the fitting of an entire new barrel. But more often the old barrel is bored out to a sufficiently large diameter to permit the insertion of a new tube which is bored, rifled and chambered as desired. This is not a very costly operation, and can render serviceable what might otherwise be a practically worthless firearm and, provided it has a sufficiently heavy barrel and suitable action, bring it to first-class target accuracy. Conversion from ·22 rim-fire to ·22 Hornet means re-chambering, but the pitch of the rifling remains unchanged.

Some action alterations are necessary. The extractor usually has to be replaced or altered if a different cartridge is to be used, and if the cartridge will be one producing a higher pressure, the firing pin may have to be reduced in diameter and the hole through which it operates bushed.

·22 Light Sporting Rifles

Very many models of light rifles of ·22 calibre have been made, varying from the lowest cost mass-produced articles to weapons similar in price and finish to the general run of target rifles.

These sporting rifles are light in weight mainly because

* Since this was written, Westley Richards have built some Anson & Deeley action Hornet rifles.

sportsmen do not like having to carry a heavy gun, and are reasonably *mechanically* accurate, being capable of hitting a rabbit in the head at the ranges at which they are intended to be used—*e.g.* up to 60 or 70 yards—but they are not easy to hold steady on the mark, and the majority are supplied with crude open sights adjustable for elevation only.

For effective rook and rabbit shooting a somewhat heavier barrel than that of the average ·22 sporting rifle is sometimes preferred, and improved sights, such as an adjustable peep backsight used with blade or bead foresight or, better still, a telescopic sight of suitable magnification.

Small sporting rifles of this class are limited in their utility. At short range they are much less effective than shotguns; at long range they require skilful handling; and they may cause ricochets. Advantages of the ·22 are that it uses ammunition costing less than one quarter the price of shotgun cartridges, and it makes little noise.

Target Rifles

Target rifles are designed to assist the shooter to hit consistently a small bull's-eye. A target rifle should place all its shots as nearly as possible in the same place on the target when the aim is the same and the shooter does not in any way vary his hold or trigger release from shot to shot. It should, in fact, produce a small group. The sights should be such that when a group has been shot on a target, but the centre is not coincident with the centre of the bull, they may be adjusted so as to bring in the centre of the next group to the centre of the bull.

To produce a small group a target rifle should have a heavy barrel well bedded in the stock, and the bore and rifling should be even and in perfect condition. The condition of the chamber is important, as an imperfect chamber distorts the bullet, causing it to leave the muzzle in an erratic manner. The type of action is also important when targets are shot with heavy charges, but does not matter quite so much for ·22 rifles.

In order that barrel-flip shall not be erratic, the barrel should be carefully bedded throughout its length, or fixed to the fore-end at two definite points, or fixed at one point of a fore-end of semi-floating type such as that of the B.S.A. 12/15 (see Fig. 29).

The fore-ends of modern target rifles are long to permit the

left hand to support them well forward, and are preferably broad and flattish on the underside so as to rest steadily on the hand. The butt has little bend and the comb is high so as to come well against the cheek. A cheek-piece is usually provided so that the

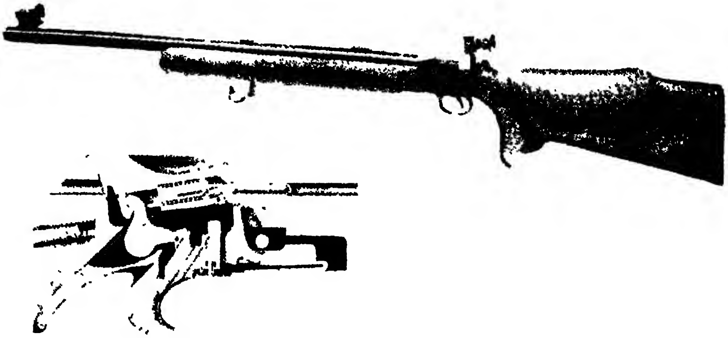


Fig. 30.—B.S.A. "International" Target Rifle.

By courtesy of Mr. Walter A. Lee, Photographer.

Fig. 31.—Home-made Palm-rest Attachment to Vickers Target Rifle.

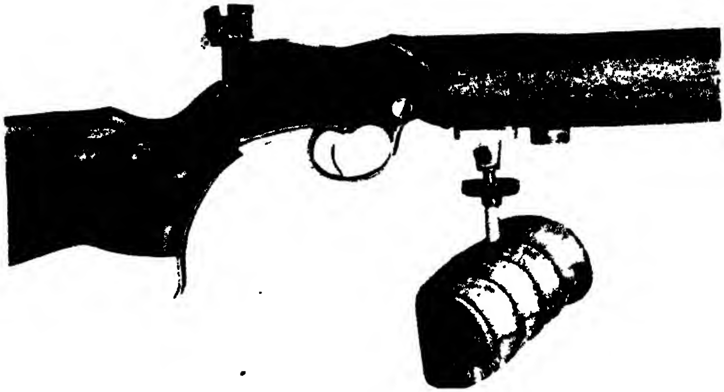
stock will lie against a large surface of the cheek correctly positioning the eye relative to the sights.

Target rifles are comparatively heavy because, apart from the weight of the barrel mechanically reducing the size of group, a heavy rifle is more easily held steady on the mark. The usual weight of present-day English rifles is about 9½ lb. Rifles with

extra heavy barrels (called in America bull guns) weigh upwards of 11 lb. Light target rifles for boys weigh 6 to 7 lb.

Target rifles are fitted with sling swivels, usually placed at each end of the fore-end, to take a shooting sling, for nearly all small-bore target-shooting is with the sling.

It is now usual to fit a hand-stop to prevent the left hand from sliding forward when the sling is used, making it unnecessary for the shooter to grip with the left hand. Some rifles are made fitted with adjustable hand-stops (see Fig. 30), but many other target rifles are manufactured with a plain fore-end to which the shooter has a proprietary hand-stop fitted or, more commonly,



By courtesy of Mr Walter A. Lee, Photographer.

FIG. 32.—HOME-MADE PALM-REST ATTACHMENT TO B.S.A. 15 TARGET RIFLE.

fits his own makeshift hand-stop (see Fig. 29) when, after much trial, he has decided just where the hand-stop can best be placed.

The barrels of target rifles are long to give a long distance between foresight and backsight, making sighting easier, also assisting steady holding.

MILITARY RIFLES

As this book is written from the point of view of civilians interested in firearms for competition or sport, reference to war weapons of a kind not available to the civilian is not made. But military rifles can be purchased, and are very largely used for " full-bore " target practice and competition, and re-stocked and

used with suitable ammunition they serve very well for the shooting of medium game.

The requirements of a military rifle are that it shall be of moderate weight, for the soldier has to carry it long distances with much other equipment: the action must be capable of operating in the most adverse conditions, full of mud, sand or other dirt, and should be capable of being used in prolonged firing. As many shots may be fired in succession, heating the barrel, the soldier's hand must be protected from burns by an extended stock. The sights of a military rifle have to be almost invulnerable, allowance being made for the weapon being in use by men of all ranges of intelligence, a condition which precludes the care that might otherwise be given. In addition, design has to be such that rifles can be mass produced in large quantities by modern factory methods at low cost.

These requirements militate against the production of rifles of attractive appearance. Neither are all perfect from the point of view of the target rifleman. For example, the barrel of the Lee-Enfield Mark III is the lightest of any military rifle, and therefore not ideal for accuracy. Heavy barrels can now, however, be fitted to the Lee-Enfield for target purposes.

As described in the previous chapter, the action of the Lee-Enfield is not good for the best accuracy, accuracy having been sacrificed to rapid manipulation and reliability.

All military trigger actions are on the double-pull system in which the mechanism is so arranged that after a long, light pull of the trigger the motion is stopped by a heavier resistance, the firing pin being released by a further short heavier pull.

The three British rifles used in competition are the Short Magazine Lee-Enfield, Mark III, officially known as Rifle No. 1, the Pattern '14 Enfield Rifle, officially known as Rifle No. 3, and the Rifle No. 4 Mark I Short Magazine Lee-Enfield (see Fig. 33).

Rifle No. 1 has a blade foresight dovetailed at right angles to the barrel, capable of lateral adjustment. The backsight is an open U-notch mounted on the barrel with a zero setting of 200 yards. It is attached to a bed which encircles the barrel and is fixed by a cross pin.

The stock is of the two-piece type. The butt is made in three ordinary lengths, the long and short butts being marked with the letters " L " and " S " on the top. For special use during the

1914–18 war extra short butts, named " Bantams ", were made and stamped with the letter " B ". The magazine holds ten rounds. This rifle is obsolescent in military circles, but remains a great favourite with Bisley riflemen for all range shooting.

By courtesy of Messrs. Parker-Hale, Ltd.

FIG. 33.—THE BRITISH SERVICE RIFLES USED IN COMPETITION AT BISLEY.

1. Rifle No. 1, Short Magazine Lee-Enfield Mark III. 2. Rifle No. 3, Pattern '14 Enfield. 3. Rifle No. 4, Short Magazine Lee-Enfield Mark I.

The general tendency throughout the years has been for military rifle calibres to reduce. The first British breech-loading service rifle, the Snider, had a ·577 bore: the Martini which followed it was a ·450. Then came the ·303 Lee-Enfield. In

1913–14 a new pattern of rifle of ·276 calibre was under trial. This had a heavier barrel than the S.M.L.E., and in place of the ordinary backsight a light aperture sight was housed between projecting flanges on the bridge over the action. It was more ballistically efficient than the S.M.L.E., but flash and muzzle-blast were excessive. During the war of 1914–18 a large number of rifles of this pattern were made but modified to take the ·303 Mark VII cartridge, and were known as Rifle No. 3 1914 pattern or, briefly, P.'14.

The P.'14 is of modified Mauser action and is extremely accurate. It has a blade foresight and two aperture backsights, one fixed and the other on an adjustable leaf. Unlike Rifles Nos.

TABLE 19

	No. 1 S.M.L.E., Mark III	No. 3 Pattern '14	No. 4, Mark I
Length . . .	3 ft. 8½ ins.	3 ft. 10½ ins.	3 ft. 8¾ ins.
Weight . . .	8 lb. 10 oz.	10 lb.	9 lb. 3 oz.
Barrel length .	25·19 ins.	26 ins.	25·19 ins.
" weight . .	2 lb. 2½ oz.	2 lb. 14½ oz.	2 lb. 9 oz.
Stock . . .	Two piece	One-piece	Two piece
Handguard . .	Two piece	Two-piece	Two-piece
Action . .	Lee	Modified Mauser	Lee
Bolt length . .	7 ins.	7½ ins.	7 ins.
" travel . .	3·5 ins.	4·75 ins.	3·5 ins.
" turning . .	0·5 ins.	0·75 ins.	0·5 ins.
" head . .	Detachable	Fixed	Detachable
" lugs . .	Two rear	Two front	Two rear
Grip . . .	Pistol	Pistol	Pistol

1 and 4 it has a one-piece stock. The American '17 Enfield rifle is based on the design of the P.'14, but differs in having a ·300 bore. Many of these American rifles have been re-stocked or re-barrelled for sporting purposes.

The modern No. 4 rifle is essentially a Short Magazine Lee-Enfield, but it has a barrel 6½ oz. heavier than that of rifle No. 1, and has an aperture backsight.

The War Office has recently given particulars of a new rifle with which it is proposed to rearm the British infantry. This is of ·280 calibre, of lighter weight than the ·303, and self-loading. It will be used with a rimless cartridge weighing 18 per cent. less than the Mark VII ·303 round, and of shorter length. But trials are understood to have shown that the new ·280 bullet has ample wounding power and increased penetration

as compared with the ·303 at the ranges at which it is intended to be used.

The new rifle looks like a machine carbine. The butt is in a straight line with the barrel, a pistol-grip projects below the centre of gravity of the rifle, and this, and the trigger mechanism, are in front of the magazine, which holds twenty rounds. The rifle is carried by a handle on top which contains what is described as an optical sight.

The rifle did not satisfy all members of the North Atlantic Treaty Organisation: the American experts favouring a higher velocity and maintaining that an 0·30 calibre was necessary to give a knock-out blow. The latest information is that an acceptable cartridge for this rifle is on the way.

For target-shooting, military rifles may be adjusted only in accordance with the rules of competition. These as set out for the Bisley meeting are given in Chapter XVIII.

Quality of Rifles

Should anyone ask: What does it cost to buy a rifle? no simple answer can be given, for there are such extreme differences in qualities and methods of manufacture and materials used. The most expensive rifle is the double big game rifle, which has all the attributes of a best shotgun, together with an additional few requirements. It is possible to pay more than £500 for one of these, in spite of the fact that there is no purchase tax on rifled arms. A best-quality magazine rifle can be purchased for less than one-third the price of a double, but it is still an expensive item.

The high price of a best-quality rifle or gun is accounted for by the materials used, and more particularly the very fine handwork involved in its manufacture. Wherever machinery can be employed, cost is reduced proportionately. But English best rifles and guns are virtually, as the Americans style it, "custom made"—*i.e.*, built to order by the finest craftsmen, even though the patterns may be catalogued as standard.

These best rifles are finely finished externally with engraving of the metal-work and checkering of the stock, which all means money, but the ornamentation is really quite a small part of the total handwork, much more of which is involved in fitting the parts of the action and fitting woodwork to metal-work.

Of medium price are the better-quality, mass-produced weapons. These can generally be said to be very superior to similar articles of foreign manufacture. They cost less than "best guns" because less handwork is put into them and there are not so many refinements of balance and weight, which mean cutting materials to waste. But they are all very sound and serviceable. Still lower in price are remodelled military rifles reduced in weight by shortening the barrel and remodelling the stock, and with provision of sporting sights; and also the general run of mass-produced target rifles, in which handwork is reduced to a minimum, but for which good-quality materials are used.

For stocking inexpensive rifles of ·22 calibre selected French walnut, oil-polished, is out of the question, and stained hardwood finished with varnish has to serve. This makes it possible for these rifles to be sold at prices ranging from a few pounds upwards, according to pattern.

Pistols

At one time all pistols were single-shot, but the revolver type of repeating mechanism was introduced a considerable time prior to the invention of metallic cartridges or even the percussion system. Now most pistols are repeaters of either the revolver or the semi-automatic type, the single-shot pistol seldom being used for other purposes than target-shooting.

Single-shot Pistols

These are mostly shaped in general outline like a revolver, but without a revolving cylinder. They usually unload by breaking down, although some Continental "free-pistols" have breech blocks actuated by an under-lever.

The single-shot pistol is the best for target accuracy because, unlike the revolver, the cartridge is inserted into a chamber that is one with the barrel, which, unlike that of the semi-automatic, is firmly fixed to the action. Single-shot target pistols usually have heavy long barrels to assist steady aim.

The Webley single-shot target pistol breaks down to eject on the trigger guard being pulled forward and downward. It has a 9-inch barrel and large comfortable walnut grip which contains a counterweight and has a thumb rest. Grips for left-handed shooters are available. The weight of the pistol is 2 lbs. 5 ozs.

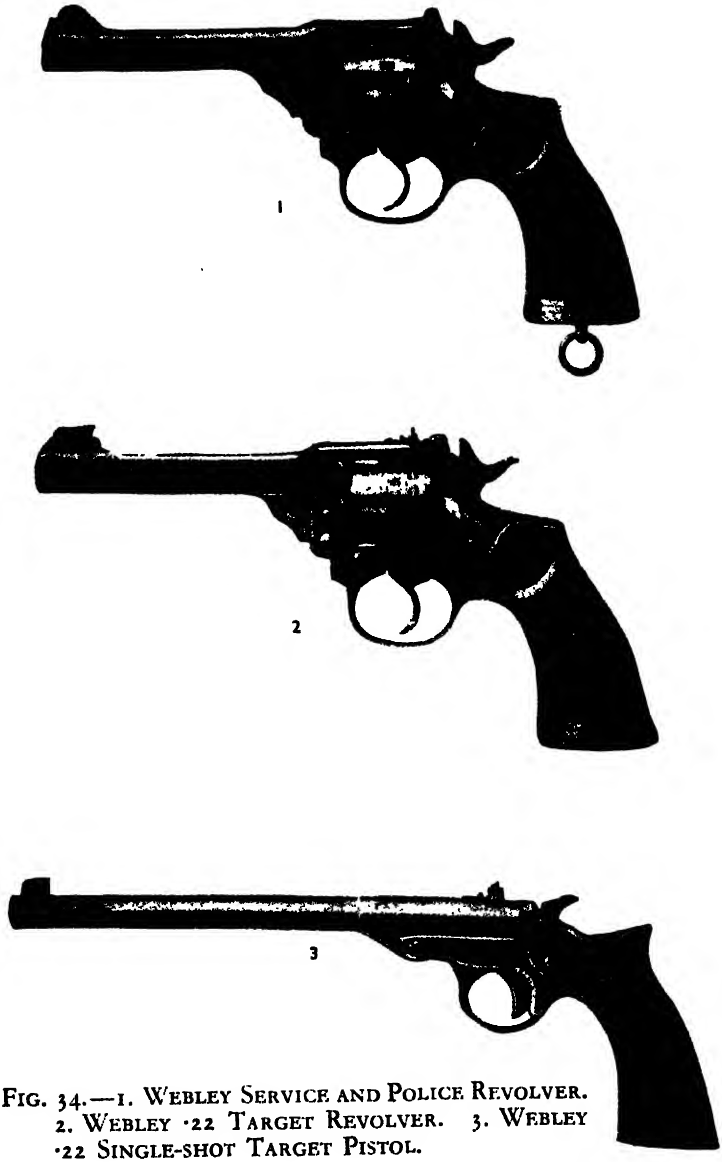


FIG. 34.—1. WEBLEY SERVICE AND POLICE REVOLVER. 2. WEBLEY ·22 TARGET REVOLVER. 3. WEBLEY ·22 SINGLE-SHOT TARGET PISTOL.

and the trigger pull as issued from the factory $2\frac{1}{2}$ to 3 lbs. The backsight is adjustable for both elevation and windage and locks securely after adjustment.

Revolvers

It is usual to speak of "pistols and revolvers", for although revolvers are pistols, they are so important, long established and distinctive a type that they are classified apart from all other pistols, single-shot or repeating.

The mechanism of a modern revolver involves a revolving cylinder containing a number of separate chambers (frequently six), each of which holds a cartridge, which in turn is brought into line with the barrel and fired. The cylinder is rotated mechanically whenever the hammer is cocked, and is locked in position when the pistol is fired.

With this arrangement it is unavoidable that some leakage of gas occurs between the chamber and the barrel, and it is possible, if a revolver is badly made or becomes worn, for the chamber not to line perfectly with the barrel. Also the bullet, after leaving the cartridge, must travel for a good fraction of an inch before it engages with the lands of the rifling and commences to rotate. All these factors involved by the revolver mechanism tend towards inaccuracy of shooting. Nevertheless, well-made revolvers can be quite surprisingly accurate and much more accurate than necessary for practical purposes.

The leakage of gas between the cylinder and the barrel is much less than would be expected, and does not greatly reduce velocity. Inaccuracy of alignment of chamber with barrel is, however, very serious; for if excessive it can cause an accident, and, even if slight, results in shaving off lead from one side of the bullet, causing inaccuracy and discomfort or injury to the shooter or anyone standing nearby.

The effect of the bullet having to travel a short distance before it engages with the lands is that it may "skid" a little before following the rotation of the rifling and in so doing tip sideways and become deformed. The effect of this skidding can often be seen on revolver bullets, recovered undamaged after firing, as duplication of the marks of the rifling.

Of the types of revolver at present in use, the *solid frame* and the *tip up* or *break down* patterns are most common. Most have

ejector mechanisms. For example, the Colt firm, after trying out all manner of inventions, adopted as standard a solid frame pattern, the cylinder of which swings out sideways. Other firms use similar mechanisms. This arrangement requires careful design and manufacture if proper alignment of chamber with barrel is to be ensured.

The tip up or break down pattern is perhaps most familiar in this country, being adopted in the modern Webley. On the release of a catch the revolver opens like a shotgun and a single central ejector throws out all the cartridges.

Revolvers are classed as *single action* or *double action*, according to whether they can or cannot be fired merely by pulling the trigger. A single action revolver (as, for example, an early pattern of Colt) has to be cocked by pulling back the hammer before it can be fired. A double action revolver can be fired by a long pull of the trigger which cocks the hammer, rotates the cylinder, and finally lets the hammer fall, firing the shot.

There was a type of double action shooting which came in before double action revolvers were invented. It was found that the old Colt single action revolver could be fired by pulling back and releasing the hammer if the trigger was permanently tied back or removed. This was known as "slip-shooting". There was also a method known as "fanning the hammer" with the left hand.

Single action shooting is obviously the best for accuracy in deliberate target shooting, but the double action principle is of equally obvious importance for the practical use of the weapon. Considerable accuracy is possible in double action shooting by experts. For the best results a very smooth action is required.

Single action revolvers have been manufactured of recent years in America, also some revolvers capable of being fired by double action only. But generally modern revolvers can be fired either double action or single action, as desired.

The Webley Mark IV revolvers are of the kind that breaks to eject and have a very strong cylinder latch which is operated by a thumb lever on the left. The barrel is in one piece with the frame.

These revolvers are very smooth for double action shooting besides having a crisp single action trigger release. They are also exceptionally comfortable to handle, having better shaped

grips and an ample space between the butt and the trigger guard, in which they excel most revolvers of American manufacture.

J. S. Hatcher, the American expert, in his "Textbook of Pistols and Revolvers", speaks highly of the Webley and Scott products. Of the single-shot target pistol, he stated that on first using it his score was better than his average with any gun. Of the Mark IV ·22 target revolver, he said that the handle was of excellent proportions and as regards the space between grip and trigger guard, the gun was well ahead of its American contemporaries and that shooting with it was a pleasure. The Mark VI ·455 service revolver he also considered excellent: and of the Mark IV ·38 he commented on the excellence of its grip and again the space behind the trigger guard and exceptionally light pull.

The cylinder of the Webley is removable for cleaning by taking out a screw.

The hammer is of the loose nose type. It is lifted and locked back when the trigger is released so that it cannot come in contact with the cartridge except when the trigger is pulled.

The backsight of the target revolver is of the same adjustable type as fitted to the single-shot pistol.

Revolvers should not be opened or closed with the hammer cocked, because if this is done the pawl is liable to catch on the ratchet of the cylinder and cause damage.

Semi-automatic or Self-loading Pistols

Small-calibre self-loading pistols can be operated on the blow-back system described in Chapter VII, and the breech kept closed, by the inertia of the block and the strength of the spring, for long enough to permit the bullet to leave the barrel and the pressure to drop. This principle would involve too heavy a breech block if it were applied to large-calibre pistols, and consequently these mostly operate on the recoil system, usually the long-recoil.

Comparative Advantages of Revolvers and Self-loading Pistols

Some of the advantages of a revolver as compared with a self-loading pistol are that the mechanism is simple and reliable, a misfire does not prevent another shot being fired immediately, old or faulty ammunition is not so likely to cause misfires, the

trigger-pull can be made better for accurate shooting, and the weapon is safer to handle. On the other hand, the semi-automatic pistol generally holds more cartridges in the magazine than a revolver, permits more rapid fire, is easier to load and to clean, fits the hand better, and is not so bulky to carry.

CHAPTER XI

SHOTGUNS

THE man who shoots game and wildfowl would like to have a gun capable of discharging a large amount of shot spread over a wide area in an even pattern so that he could hardly ever miss. He would like to be able to shoot this charge at long range and yet use a gun light in weight and of comfortable balance. Such a gun has never been made, because a heavy charge of shot produces a heavy recoil which needs a proportionately heavy gun to make it bearable.

If, to reduce weight, the charge of shot is kept small, either the angle of spread must be reduced or the pattern will become too thin. If range is to be long, large pellets must be used, reducing the number and thinning the pattern. The design of a shotgun is therefore a compromise between these conflicting requirements; and the type of gun and ammunition achieved by the ideal compromise depends on the kind of game to be shot.

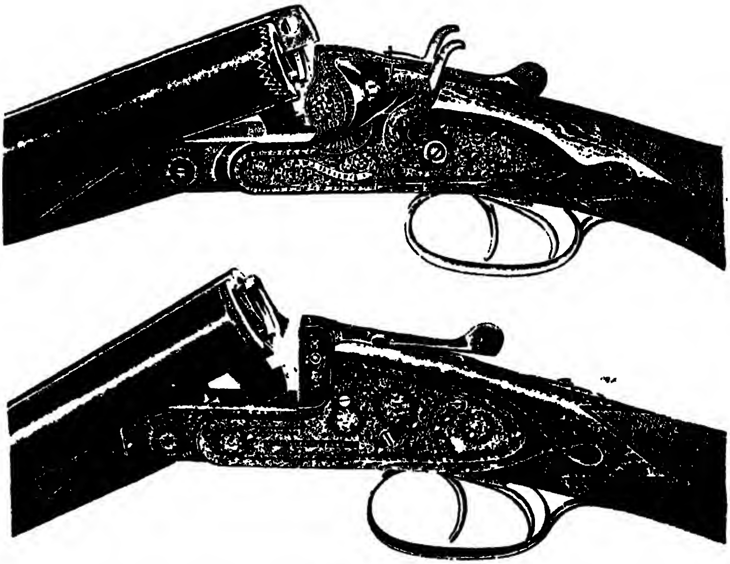
Many years ago, as a result of practical experience, it was found that the ideal gun for ordinary shooting was the 12-bore used with a 2½-inch cartridge loaded with 33 grains of powder and 1 1/16 oz. of shot. At the present time the great majority of shotguns are 12-bores, lighter guns being used by those who do not like a heavy recoil, and heavier guns for special purposes such as wildfowling.

The English shotgun has followed a traditional pattern and, apart from minor improvements and modifications influenced by fashion, the modern game gun is very similar indeed to the form perfected by Joseph Manton and other famous gunmakers of his time. It can be said that in broad outline shotguns have arrived at a finality not likely to be altered until some revolutionary change is brought about as a result of a fundamental new discovery.

This stability of design is strengthened by the practice of English shooting. For it is usual at organised shoots, where game is driven to the guns, for each man to have two guns and a loader, in order that he may fire four shots in quick succession. No action permits such rapid firing of two shots as the double,

and while a self-loading gun as used in America might be capable of firing four shots more quickly than two guns handled in succession, English sportsmen deride, in fact, dare not be seen with, self-loading or repeating shotguns, which, incidentally, are never so light or perfect in balance as a well-made double.

The design and manufacture of shotguns have therefore been directed to achieving perfection of the traditional pattern by the use of the finest materials and most exquisite workmanship, minor improvements being made as new materials or techniques



[Reproduced from a pre-war catalogue, by courtesy of Messrs. W. J. Jeffery & Co., Ltd.

FIG. 35.—ACTIONS OF HAMMER GUN AND HAMMERLESS EJECTOR.

became available, and small alterations such as barrel length, the adoption of the over-and-under principle, or the inclusion of single-trigger mechanisms, being embodied according to the dictates of fashion.

SHOTGUN BARRELS

In the previous century gun-barrels were made of Damascus twist, laminated steel, stub iron, and also less expensive materials.

Damascus twist was made by placing alternately rods of iron and steel, usually six of each kind, on one another, and welding

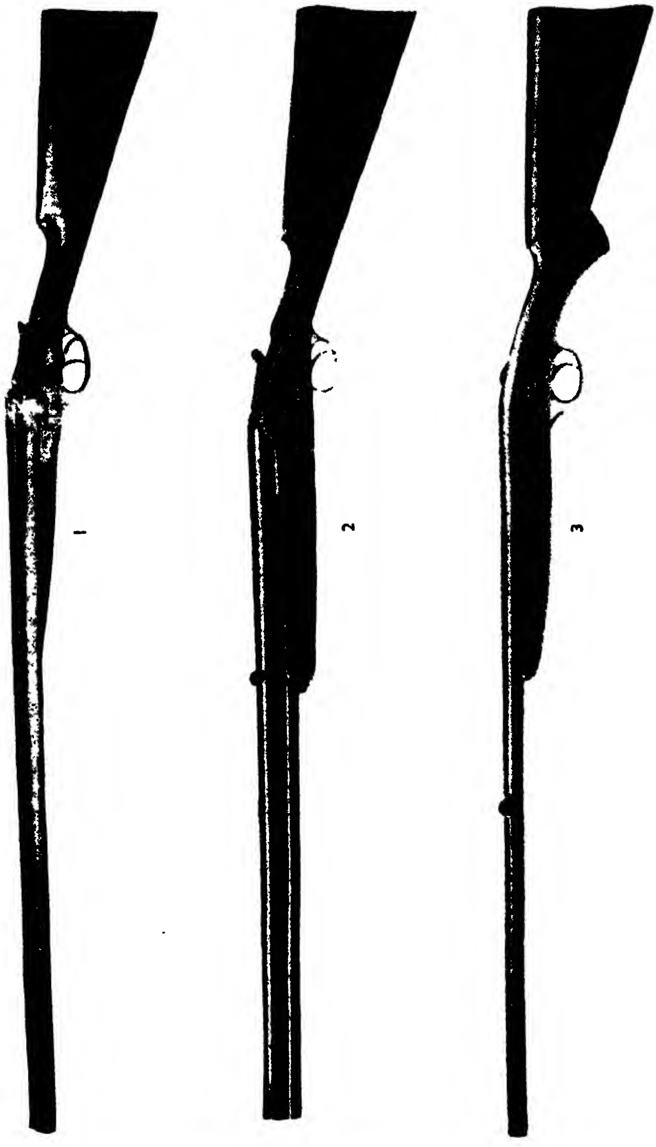


FIG. 36.—1. GREENER GUN. 2. HOLLAND & HOLLAND OVER-AND-UNDER GUN. 3. B.S.A. "SINGLE TWELVE".

them together to form a bar, which was then rolled into a rod. Next the rod was heated and twisted; after which three rods were placed together, the twist of one being in the opposite direction from those of the other two, welded together and rolled into a strip. This strip was rolled on to a tapered mandrel spirally to form a coil, which was welded to form a hollow cylinder. Three of these joined end to end made up a complete barrel.

Laminated steel barrels were made from steel scrap mixed with a small proportion of charcoal iron, which was heated in a furnace, puddled into a ball and then drawn out into strips, from which the barrel was made.

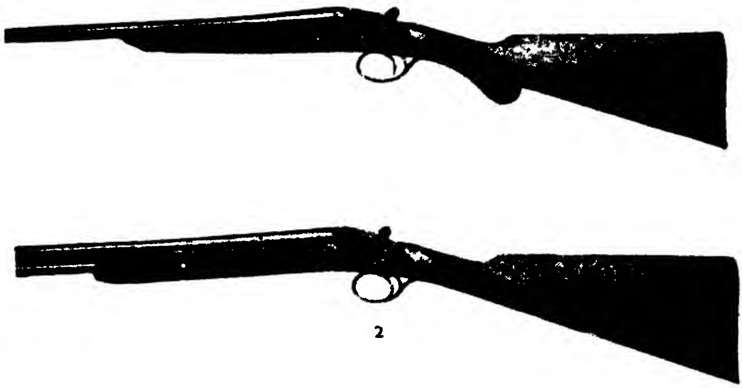


FIG. 37.—1. BOSS 12-BORE WITH SINGLE TRIGGER AND PISTOL GRIP.
2. BOSS 2[illegible]-BORE, SINGLE TRIGGER, O.U. GUN.

Stub-iron barrels were originally made by welding old horseshoes together, but later by using best wrought-iron scrap.

Damascus barrels were, and still are, much esteemed for their appearance, because the effect of twisting the two metals and re-arranging in a spiral was to produce an attractive pattern which showed up well after the surface of the gun had been polished and browned. Damascus barrels were also considered to be strong and free from flaws, but this was erroneous, for faults in the welding or impurities incorporated in the metal during manufacture were by no means uncommon, and the material was not as strong as modern steel. Laminated steel was valued for its

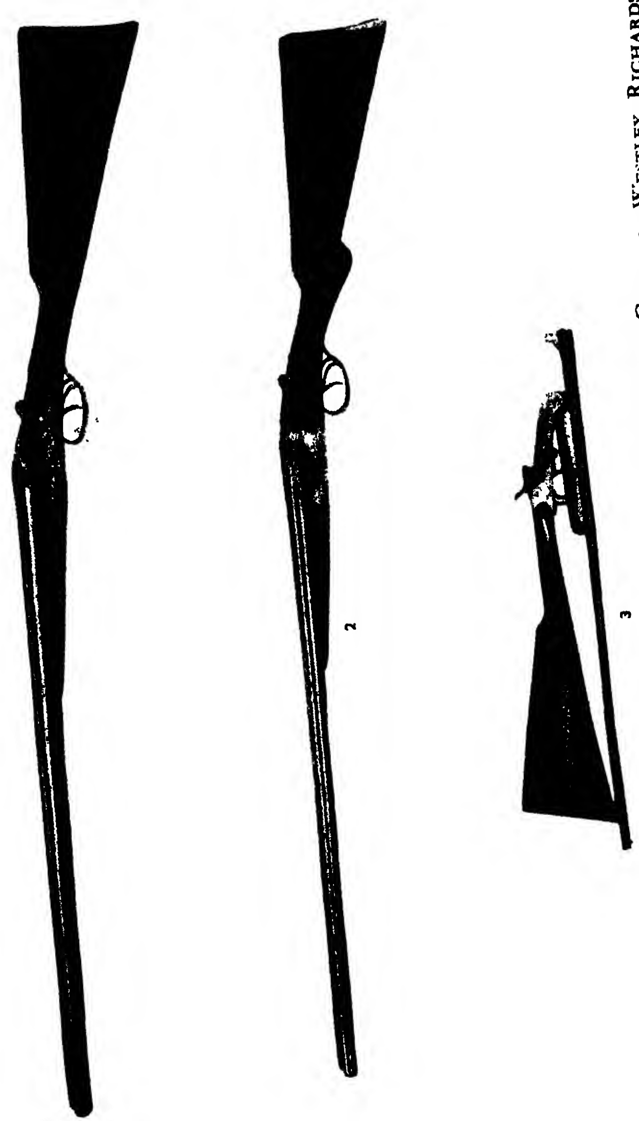


Fig. 38.—1. Westley Richards "Modele de Luxe" Sidelock Gun. 2. Westley Richards "Modele de Luxe" Gun with Special Engraving and Checkering. 3. Cogswell & Harrison "Certus" Folding Fourten Gun.

hardness and closeness of grain, but was inferior in appearance to Damascus twist.

Modern gun barrels are almost invariably made from high-quality steel, because it is now possible to produce steel virtually free from flaws and impurities, and this material is much stronger and more reliable than any used formerly. The *blanks* forged from the steel are made into barrels by machining and drilling out the solid metal, more material being cut to waste than remains in the finished article. This applies to the great majority of modern shotguns, although some of the cheapest guns have barrels of drawn steel tube.

Most guns have their barrels secured to the action body by a locking mechanism known as the Purdey double bolt. Two lugs known as the *lumps* project from the underside of the barrels and fit in to the *bar* or forward projection of the action body, where, when the gun is closed, they are locked in position by the *bolt*, which is actuated by a *lever*. These lumps undergo great stress during the firing of the gun, and for this reason need to be very securely fixed to the barrel.

This affects the price and quality of barrel, for cheap or moderate-priced guns have barrels with the lumps brazed on according to a number of alternative methods. On the other hand, the very best barrels have *chopper lumps*—*i.e.* each barrel is made in one piece, with a large lug of steel, which is eventually cut down to form the two lumps.

The two barrels of a double-barrelled gun are joined together at the breech, where they are brazed to the lumps or, in the case of barrels with chopper lumps, where the lumps of each barrel are brazed together, the brazing extending for about 2½ inches from the breech. The barrels are so set at an angle one with the other that, allowance being made for the difference of recoil according to which barrel is fired, both barrels will aim at the same spot at a distance of 40 yards. In addition to brazing at the breech they are secured in this position by packing pieces, which are eventually concealed by the top and bottom ribs; but it is the brazing of the breech which is mainly responsible for holding the barrels together. The top and bottom ribs are soldered in position.

In the brazing of gun-barrels, great care has to be taken not to raise the steel to too high a temperature, since this (as mentioned in Chapter XII) would greatly reduce its strength and

Fig. 39.—Cogswell & Harrison Extra Quality Victor Ejector Game Gun.

weaken the gun at a place where strength is of the utmost importance.

Choke

The spread of the shot can be varied by very slight reduction of internal diameter of the barrel near the muzzle, which is known as *choke*. The term *full choke* is applied when the diameter is

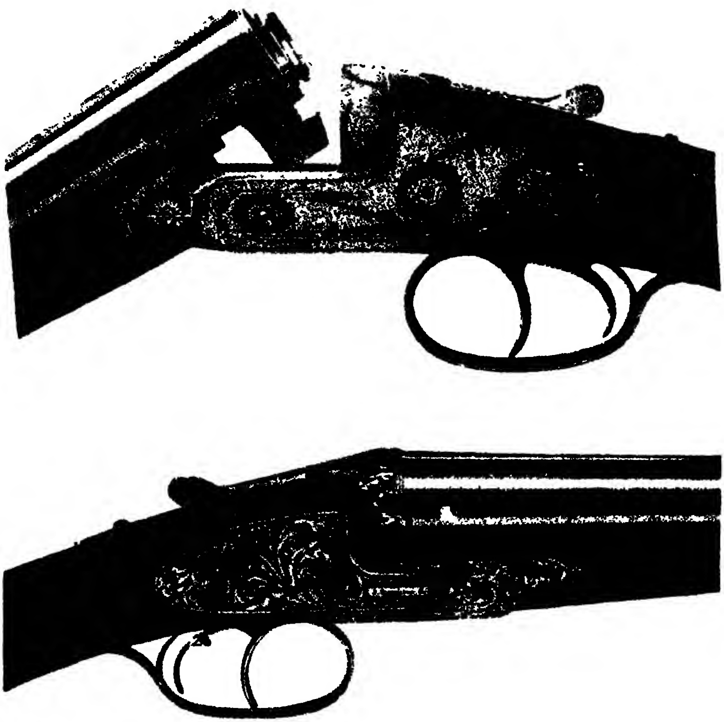


FIG. 40.—PURDEY HAMMERLESS EJECTOR ACTIONS.
Above: LIGHT 12-BORE.
Below: SPECIAL FINISH.

reduced by forty-thousandths of an inch or forty *points of choke*. Three-quarter choke, half-choke and quarter-choke are proportionately lesser reductions of diameter, while the term *improved cylinder* refers to three or five points of choke (three points is the normal minimum), and *true cylinder* when there is no reduction whatsoever. Choke is applied to a length of barrel of not

more than 1¼ inches at the muzzle, which is approached by a cone or taper about 1 inch long.

The effects of choke are to concentrate the shot in a smaller area and improve the pattern. Taking as standard No. 6 shot, the percentage of the total charge concentrated in a circle of 30 inches diameter at a distance of 40 yards from the muzzle is approximately 70 per cent. for full choke, 65 per cent. for three-quarter choke, 60 per cent. for half-choke, 55 per cent. for quarter choke, 50 per cent. for improved cylinder, as against only 40 per cent. if the barrel is not choked at all.

When ordering a gun the amount of choke selected depends on

FIG. 41.—STEPHEN GRANT BEST QUALITY SIDELOCK AND JOSEPH LANG BEST QUALITY BOX LOCK.

the purpose for which the gun will be used, together with the ability of the shooter. For general purposes a modified cylinder for the right barrel and a moderate degree of choke for the left is perhaps most popular; for wildfowling full choking of both barrels is usual, with perhaps more spread in the right than in the left. Pigeon guns are usually fully choked. If in doubt when ordering, it is advisable to order rather more choke than less, for choke can be reduced very much more easily than it can be increased.

SHOTGUN ACTIONS

The action body to which the butt is fixed and the barrel hinged is cut from a solid L-shaped piece of high-quality tough steel. The part that projects forward under the barrel is known

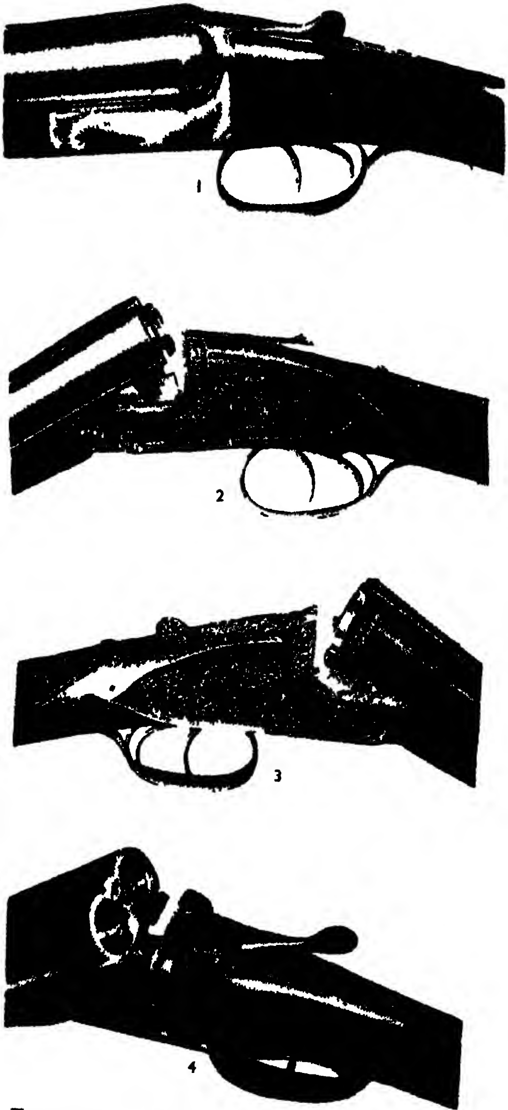


FIG 42 —HAMMERLESS EJECTOR ACTIONS

1 Webley & Scott 2 Jeffery 3 Rigby 4 Thomas Bland

as the *bar*, the upper face of which is called the *flats*. The vertical face which closes the breech is known as the *action face* or *standing breech*, behind which projects the *straps* to which the stock is secured. The forward lump of the barrel hooks on to the *cross-pin* or *action pin*, which passes through the front end of the bar of the action. The lumps are held in position by the bolt when the breech is closed, actuated by the lever known as the top lever (the usual position), side lever or bottom lever, according to its position. The *knuckle* is the rounded end of the bar about which the fore-end of the stock rotates when the barrels are moved relative to the action.

The action needs to be of great strength to withstand the backward thrust of the explosion, and consequently not only is good material necessary, but the shape of the parts must be such that stress is not concentrated in any one place to such an extent that fracture might occur. Various devices are used in addition to the bolts to secure the action. For example, to prevent backward movement of the action face due to bending of the bar, a top extension is sometimes added. One of the most effective types of top extension is the doll's head, a circular projection with a narrow neck which dovetails into the top of the action body when the breech is closed, and does not interfere with the opening and closing of the gun. Nevertheless, on the action body being bent (microscopically) by the force of the explosion, the doll's head receives part of the load and stops excessive movement. Other forms of top extension include a projection held in place by a cross bolt when the action is closed, but these are effective only if the moving parts are made to fit perfectly.

The fitting of the body to the barrel is handwork for which no gauges are employed. The surfaces to be fitted together are blacked with an oil lamp, and the metal filed or scraped down until there is a perfect contact of the whole surface.

Locks

The first percussion guns were hammer-guns with external hammers striking on firing pins and rendered safe by being placed on half-cock, as described at the end of Chapter VII, and therefore did not require any special safety-catch. Those made during and after the last quarter of the nineteenth century had *rebound locks*—*i.e.* the hammers rebounded after firing, so as to take the weight

off the firing pin, permitting the gun to be opened easily: it was necessary to lift the hammers of earlier guns before opening the action.

Nearly all modern shotguns are *hammerless ejectors*, which means that they have internal concealed hammers and that when the gun is opened the fired cartridges are thrown out of the chamber.

The locks of hammerless ejector guns (and rifles) fall into two classes: the box lock, or Anson and Deeley lock, a Westley Richards invention; and the side lock, which includes the bar-action side lock and back-action side lock.

In the Anson and Deeley lock the mechanism which fires the cartridge is arranged in a slot cut in the action body below the breech end of each barrel. There is no separate firing pin, for the hammer—or tumbler, as it is called—is arranged to strike directly on the cap of the cartridge. The locks are cocked by opening the gun. The safety-catch locks the trigger, but not the firing mechanism.

The locks of the bar-action side lock are let into the sides of the action body, that part of the mechanism which extends forward being recessed into the sides of the bar. Back-action side locks are constructed with the whole of the firing mechanism behind the action face or standing breech. They are covered by two steel plates known as the side plates, to which the axles of the working parts are fixed. These side plates give the characteristic appearance to side lock guns by which they can be distinguished at once from guns with box locks (see Figs. 35 to 43).

One important advantage of the side lock mechanism is that it normally incorporates an intercepting safety which prevents the arm from being jarred off. Another difference as compared with the box lock is that the side lock tumbler falls on a striker, firing pin or plunger, whereas the box lock tumbler itself strikes the cartridge. (To protect the striker from damage on snapping an empty gun after closing, snap caps are used. These are dummy cartridges with spring-loaded caps that absorb the shock of the tumbler.)

Ejectors

The extractor of a gun rests behind part of the rim of the cartridge, and on the action being opened it pushes the cartridge partly out of the chamber. A double which is not an ejector gun

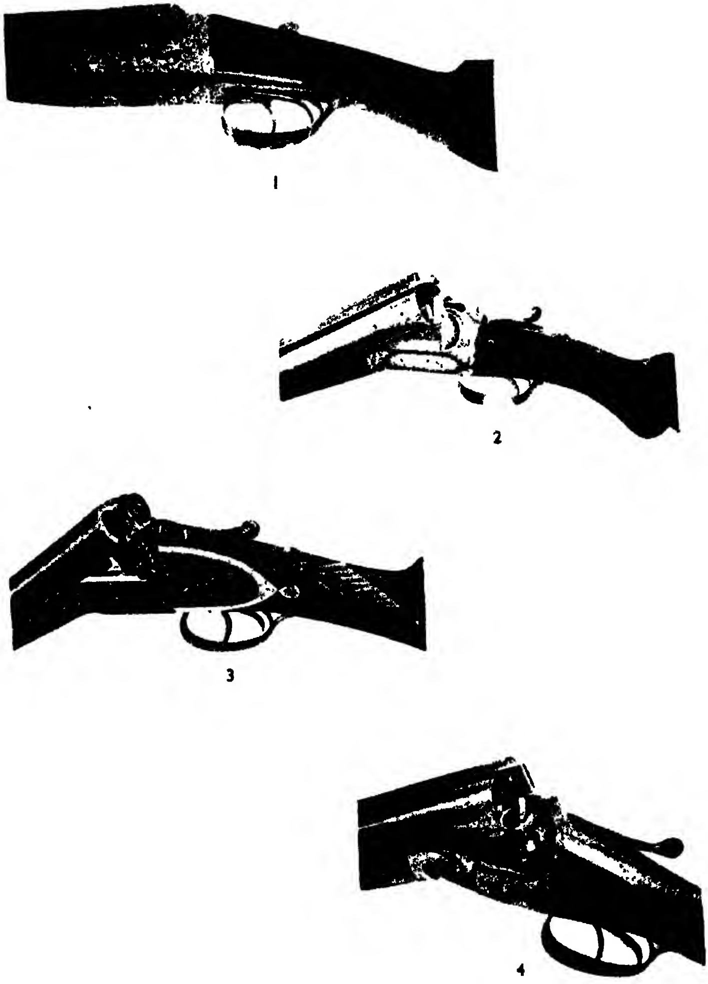


FIG. 43.—HAMMERLESS EJECTOR ACTIONS.

1. Westley Richards with Special Ornamentation. 2. Westley Richards showing Doll's-head Top Extension. 3. Beesley Best Quality Sidelock. 4. Greener showing Cross-bolt Top Extension.

has one extractor which acts on both cartridges at the same time, but a gun which is fitted with ejectors has two separate extractors which are spring operated, and so arranged that when the gun is opened, fired cartridges are thrown out, but cartridges which are not fired are partially extracted.

Single-trigger Mechanisms

The use of a single trigger to fire in turn the two barrels of a gun or double rifle permits increased speed of firing, which is appreciated by some, but not all, sportsmen. Single-trigger mechanisms are complicated because they have to be arranged to prevent the firing of the second barrel due to involuntary second pressure on the trigger caused by the recoil on firing the first barrel. This difficulty is overcome in different ways. For example, some mechanisms involve a delay component which prevents the immediate firing of the second barrel. Others work on the principle that the first pull of the trigger fires one barrel and the third pull the other, the second pull not causing firing.

Selecting a Gun

When buying a new gun most men have to consider price. A best gun is very nice to have, but it is beyond the means of the majority of sportsmen, and a very good sound and effective weapon can be purchased for a fraction of the price. The side lock action is almost invariably used for high-grade guns, but when cost has to be considered a box lock may be selected because it makes possible the production of a better gun at a limited price. Best guns are most frequently made for game shooting in which the advantages of a very low weight and perfect balance are most appreciated: for wildfowling in which comparatively heavy guns are used and in which rough usage occurs, a much cheaper gun is justified.

For ordinary game shooting the 12-bore weighing about $6\frac{1}{4}$ lb. and having a barrel length between 25 and 30 inches, used with $2\frac{1}{2}$-inch cartridges and 1 or $1\frac{1}{16}$ oz. loads of shot is generally preferred. Game guns of 16- and 20-bore are also popular, but to a much lesser extent than the 12-bore, being used by ladies or shooters who like particularly light guns with proportionately light load. The ·410 calibre is very popular for small guns for use against vermin and ground game (see Fig. 38).

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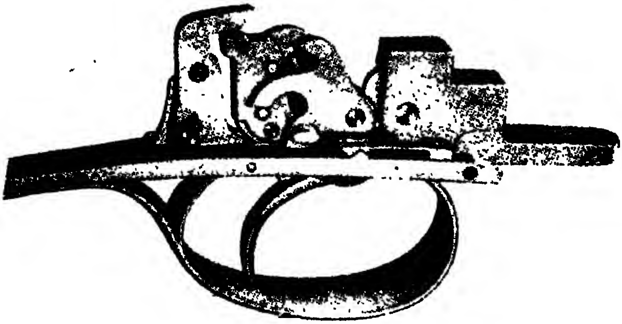

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Fig. 44.—1. Westley Richards Box Lock Action with Detachable Locks and Single Trigger. 2. Westley Richards Single Trigger Mechanism Set for Firing Right Barrel. 3. Westley Richards Sidelock.

A normal 12-bore game-gun and cartridges are also suitable for skeet, because at this game long shots are rare and a higher shot charge than used for game-shooting is unnecessary. For trap or down-the-line shooting special guns are used. A clay bird with its edge towards the shooter presents a very small target and may easily be missed if the pattern is not good. This calls for a gun and cartridge producing even patterns at 40 yards and the most suitable shot charge. Trap shooting rules, in Great Britain, at the present time do not allow guns of larger than 12-bore, loads of shot heavier than 1⅛ oz., or shot larger than No. 6 (English). Within these limitations it is recommended that a 12-bore gun taking a 2½-inch cartridge should be used, and the cartridge loaded with a selected smokeless powder and up to 1⅛ oz. of No. 7 shot.

The gun for down-the-line should be heavy—as much as 7 lb. or even 7½ lb. weight. A barrel length of about 29 inches is desirable and a rib of the engine-turned, matted or file-cut type or, as is popular in America, the raised or ventilated type. Over-and-under guns are particularly suitable. The gun should be well choked, particularly in the left barrel, should have a slightly shorter stock than a game gun and slightly less cast off, and it should be on the straight side, so that the target is visible above the muzzle at the moment of firing.

Guns for Wildfowling

The 12-bore magnum weighing 7½ to 8½ lb. and taking 3-inch cartridges loaded with charges of shot of 1½ oz. is particularly good for wildfowling, for it is lighter and handier than a large gun such as an 8-bore, and yet very effective. A magnum can be effective up to 70 yards. A barrel length of 30 inches is recommended.

A 10-bore gun chambered for 3¼-inch cartridges, weighing about 10½ lb. and having a barrel length in the region of 32 inches, taking 1¾ oz. of shot, is also very effective.

8-bore guns are comparatively rare, and too heavy for some wildfowlers, but some consider them ideal for duck or goose shooting. These guns are chambered with 3¼-inch, 3½-inch, 3¾-inch, 4-inch and 4½-inch cartridges and weigh from 12½ to 16 lb. A suitable barrel length is 34 inches, and a normal charge of shot 2⅜ oz. for the 3¾-inch case.

A double-barrelled 4-bore gun weighs about 20 lb., the single barrel only about 15 lbs. The 4-bore cartridge is 4 inches long and takes 3¼ oz. of shot. A suitable barrel length is between 40 and 45 inches.

Punt Guns

No discussion of wildfowling is complete without reference to punt guns, although these hardly fall within the definition of small arms.

A punt gun is a large fowling-piece designed for mounting forward in a duck punt on a crutch swivel or other mechanical rest. Punt guns have bores from 1 to 2 or more inches diameter and take very large charges of powder and shot. For example, a 1½-inch bore is probably most frequently met with; such a gun would take about 1¼ lb. of shot and 3¾ oz. of powder; its length would be in the region of 8 feet and its weight 120 lb.

A few firms used to specialise in the manufacture of punt guns, including Holland & Holland Ltd., W. W. Greener Ltd. and Thomas Bland & Sons. In the last century Holland & Holland made numerous punt guns from 1-inch to 1¾-inch bore, the most common being the 1½-inch. As a rule they were single barrel, with steel barrel bored out of the solid. They also made a few double-barrel 1½-inch bore with 9 feet steel barrels, weight 230 lb. firing 3 to 4 oz. of powder and 16 to 20 oz. of shot. These had a special screw breech, with revolving head, to a design worked out by the firm for Sir Ralph Payne Gallwey's big gun, mentioned in many books on wildfowling.

Thomas Bland & Sons Ltd. are still making punt guns, and have made several since the war. In this respect the firm is probably unique, for it is doubtful if anyone else in the world is competing with them. These are 1½-inch bore breech-loading guns of the screw-breech type. They have a barrel length of 7 feet 6 inches, an overall length of 9 feet, and weigh 120 lb., and are fitted with trunnions for the attachment of a breeching-rope. They take an I.C.I. paper cartridge loaded with 20 oz. of shot and 4 oz. (maximum) of black powder. The price quoted in 1951 was £125.

Punt guns in use still include many muzzle loaders, for breech-loading punt guns were always costly, and the process of loading from the muzzle is not a serious disadvantage seeing that a punt

gun is very seldom fired more than once during an expedition. Breech-loading guns are favoured by amateurs, while professional fowlers invariably use muzzle loaders, because not only are they unable to afford the price of a breech loader, but the muzzle-loading gun also costs less to use.

Double punt guns were more expensive still than single breech loaders and for this reason few have been made. They have the advantages over single guns of equal weight of being more deadly and permitting economy of powder and shot: for where there is a large company of fowl, both barrels may be fired, producing an oval pattern that covers a larger area than the circular pattern of a single barrel; while where there are but a comparatively few fowl, one barrel only need be fired. If a timing device is incorporated in the lock, one barrel can be fired a fraction of a second after the other so that the first takes the fowl on the water and the second as they rise.

The weight of a punt gun should not be less than 6 lb. for every ounce of shot in the charge. The length of the barrel should be about sixty calibres. The powder charge should be about one-fifth of the weight of the shot. The thickness of wad between powder and shot should never be less than one calibre.

Gun punts are long, low craft somewhat similar to large collapsible canoes in general appearance, but of sound timber construction. Half-decking and high coaming round the cockpit is usual. Some punts are not decked, but these are unsafe except for use in quiet waters. Single punts are used for light guns, and are suitable for sheltered waters only: double punts are necessary for carrying a heavy gun. A punt that can be taken out to sea should be 22 or 23 feet long, with a beam of about 4 feet. All punts are painted light grey or dirty white to make them inconspicuous.

The punt gun is supported in the crutch just behind its point of balance, and the barrel rests on a gun-rest, which is a piece of wood padded on the top side with canvas stuffed with horsehair and formed like a bridge with two arches through which the breeching rope passes. This gun-rest can be slid backwards or forwards on the foredeck with the aid of a stick which is permanently fixed to it. By this means the gun is elevated.

The recoil of the majority of punt guns is controlled by a breeching-rope which is passed forward through one arch of the

gun-rest, through a hole in the stem of the punt, and back through the other arch. If the gun has trunnions, one end of the breeching-rope is eye-spliced to one trunnion, the other is passed over the second trunnion to form a loop and the end seized to the standing part with a strong cord. If there are no trunnions, the breeching-rope is passed through a hole in the stock, over a horn on top of the stock or through a ring, and the ends knotted together.

Several early guns were swivel-guns which had springs under the barrel to absorb recoil and were mounted on heavy hardwood blocks arranged to slide in boxes on the punt floor. A rope was passed round the end of the block and through the stem of the punt. Many of these swivel-guns have been converted by the addition of trunnions.

A gun having trunnions rests in a padded crutch the support of which is screwed to the gun-beam of the punt. The gun is so positioned in the crutch that a weight of about 8 lb. is required on the stock to balance it. Turning the crutch screws it in or out of the support, so as to alter the height of the gun.

CHAPTER XII

PROCESSES OF MANUFACTURE

MANY varieties of steel and a great variety of processes are used in the manufacture of the different parts of a rifle or gun. For example, the *Textbook of Small Arms* mentioned that in the manufacture of the S.M.L.E. Rifle No. 1, action bodies were made from rectangular bars, triggers cut from bars of cross-section similar to the shape of the finished article, and barrels made from " moulds " or round bars about 1 foot long. Sheet steel pressings, spring steel and various gauges of wire are used for small parts, while drop forging is employed for rough-shaping components and at the same time improving the homogeneity of the steel.

STEEL

One of the ways in which modern firearms have been improved over early or even comparatively recent weapons is in the use of high-quality special and heat-treated steel. It is these fine materials which have simplified problems of handling high-pressure loads and made possible the safe reduction of weight, for example, in shotgun barrels. And whereas, formerly, actions of ordinary soft steel had to be heavily constructed, special steels, many different kinds of which may be used in one action, have increased safety, at the same time permitting a reduction of weight. Special or heat-treated steels also increase the life of a weapon by reducing ordinary wear of moving parts or the permanent set caused by the hammering of innumerable shots.

Steel is a term used for an alloy of iron, and broadly can be taken to mean iron containing a small amount of carbon with or without other elements. A mild steel containing a very small quantity of carbon is stronger than pure iron, but cannot be hardened without first being changed in chemical composition. If the amount of carbon is increased the steel can be hardened from soft and malleable to hard and brittle by heating and suddenly chilling, and thence reduced to any intermediate degree of hardness by tempering.

The process of case-hardening is largely used in rifle manufacture. This is the addition of carbon to the surface layer only of a steel component by heating the part in a case-hardening compound. Then the component is chilled and, if desired, afterwards tempered. The result is that the surface is hard and comparatively brittle, while the core remains soft and not easily broken by shock. Case-hardening gives the surface of the metal a mottled patina of blue, purple or brown colours which looks better than a blued finish but is much less permanent. Action bodies or other case-hardened parts can be lacquered to preserve these colours.

While steel can be hardened by heat treatment, it can also be considerably weakened if over-heated in any stage of manufacture, for prolonged excessive heat causes the growth of large crystals in the metal in place of fine-grained strong structure. Such over-heated or " burnt " steel has been produced in rifle manufacture where proper instrumental control of temperature has not been maintained. There is also the danger of damaging existing weapons in brazing during alterations, for brazing temperatures can be high enough to weaken steel.

In the action of a rifle many parts are heat-treated. All springs are, of course, tempered, as otherwise they would be practically useless : if too hard they are liable to break, and if too soft they eventually adopt a permanent set and lose their pressure. Working parts which have to be maintained at accurate dimensions are sometimes hardened throughout or else case-hardened. Sometimes the entire action body consists of a special steel, is heat-treated or is case-hardened. In the last instance, should the owner of such a rifle desire to fit special sights, the metal must be locally annealed or the surface ground off before the body can be tapped and drilled.

Barrel Making

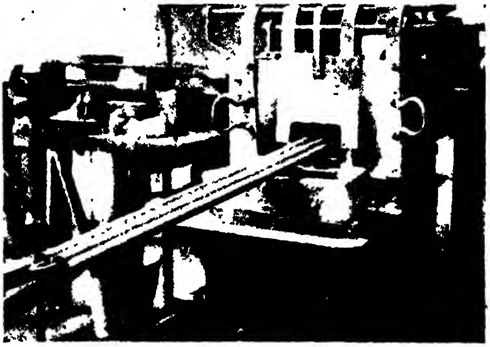
When the barrel has been forged, it is turned for exterior shape and drilled from end to end, or else from either end to meet in the middle,* and when it has been bored to the correct diameter it is tested for straightness by looking through the barrel : any

* The term " drilling " is used for cutting a hole with a drill the point of which is shaped to form the cutting edges ; while " boring " is the enlarging of a circular hole by means of a boring bar with cutting edges or separate cutters at the sides.

inaccuracy of straightness is shown by lack of concentricity of circles of shadow that are caused by reflection of light from one end. Barrels which are not perfectly straight are straightened in a machine—work that was once done by hammer.

Many forms of rifling have been tried and theories put forward, but now nearly all rifling is of the Enfield type, in which the grooves and lands are square cornered and their surfaces curved parallel to the bore. This has been proved by results to be as good as any other system; and it is the least expensive to cut.

The grooves of the rifling are cut one at a time, each groove being made in several light cuts of about one thousandth of an



[By courtesy of Messrs. Holland & Holland, Ltd.

FIG. 45.—BRAZING.

inch by a cutting tool which is pulled through the barrel and given the necessary spiral movement.

LAPPING

After rifling, good-quality barrels are lapped to remove tool-marks and any inequalities of diameter.

The lapping tool is a rod of diameter almost as large as that of the barrel. About $2\frac{1}{2}$ inches of one end is tapered down to form a jag; the other end fits into a ball bearing secured in a wooden handle made to be held with both hands. To prepare the lap, the barrel is cleaned, oiled and then dried with a clean patch. A bit of yarn is wrapped round the lapping rod just behind the jag and the rod pushed into the barrel from the chamber end until the end of the jag is about an inch below the muzzle. The rifle is fixed in a vertical position with the muzzle upwards and the muzzle

heated to " straw yellow ". Molten lead is then poured into the muzzle until the end of the barrel is filled.

When the lead has set, the lap is pushed out enough for the end to be trimmed off neatly with a file, and then for more than half its length, so that it can be inspected to ensure that a good casting

FIG. 46.—SPILL BORING.

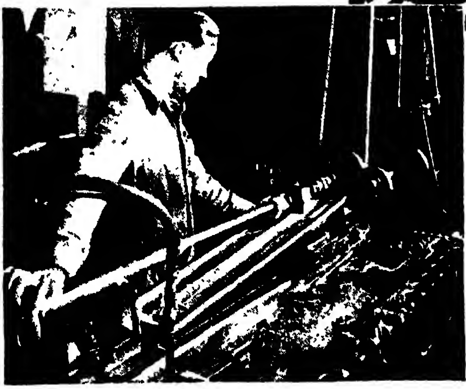


FIG. 47.—CHAMBERING.

By courtesy of Messrs. Holland & Holland, Ltd.

has been made. The exposed end of the lap is coated with fine emery and oil, then it is withdrawn to the breech sufficiently for the yarn to be removed and emery applied to the other end. If the lap should completely come out at the muzzle or the breech, no attempt should be made to put it back : it must be melted off the rod and a new lap made.

Stops should be fitted to prevent the lap from coming out of the barrel at either end during the process of lapping. The lapping rod is then passed through the barrel in full-length strokes, except where tight spots have to be removed by additional short strokes.

Ball Burnishing

As barrels are bored by rotating drills, the tool-marks on the lands are at right angles to the direction of movement of the bullet and therefore, if not removed, tend to scrape metal off the jackets of bullets. The tool-marks in the grooves, being in the direction of the motion of the bullet, have much less scraping effect, with its consequent tendency to cause fouling. Parker-Hale acquired in 1922 the process of ball burnishing introduced to them by the late T. B. Simpson, a Bisley visitor from Australia. This consists of passing sized steel balls through the barrel under pressure, and has the effect of closing up the cuts on the lands and leaving a smooth, dark, mirror-like surface. The process is particularly applicable to new barrels.

Chambering

Making the chamber that takes the cartridge is one of the most important operations in the manufacture of a rifle, because, on perfection of chamber dimensions,the safety, accuracy and smooth operation of shooting depend. If the chamber is too long, head-space may be excessive, resulting in ruptured cartridges, misfiring and inaccuracy; if it is too short, cartridges will not go in. Too tight a chamber can cause excessive pressure; too large a chamber may cause ruptured cartridges, difficult extraction and inaccuracy.

Chambering consists of reaming out the breech end of the barrel in stages with a series of chambering reamers. When the chamber has been brought to size in this way, the barrel is fitted to the action body before the finishing reamer is used, in order that head space may be gauged correctly. This finishing reamer also cuts the bullet-seat or leed, which, for best accuracy, should be so made that the tapering portions of the lands are just in contact with the bullet when the cartridge is placed in the chamber.

Blueing or Browning

When the barrel of a rifle or gun has been properly fitted to the action so that it is possible for a cartridge to be fired in it, all the

parts are finished bright. In this condition, which is known as "in the white", it is sent to the Proof House for ***definitive proof*** before complete finishing.

By courtesy of Messrs Holland & Holland Ltd

FIG. 48.—DRILLING AND RECESSING FOR INSERTION OF EXTRACTORS.

By courtesy of Messrs Holland & Holland Ltd

FIG. 49.—THREE STAGES IN CUTTING THE ACTION BODY.

A. Rough stamping. *B*. After cutting on milling machine. *C*. After several operations.

A gun left in this condition would require frequent cleaning and would be easily visible to an enemy or game. For this reason a process is applied to darken the surface.

The process of *blueing* or *browning* gives an even blue-black or sometimes dark-brownish colour, which is pleasing to the eye.

It is a process of controlled rusting in which the surface of the metal is evenly oxidised. It is not a protective process, and does not (as is sometimes believed) prevent accidental rusting should the metal-work be allowed to get wet and remain wet. But the

Fig. 50.—Machining the Action Body.

Fig. 51.—Cutting-in for the Locks.

By courtesy of Messrs Holland & Holland Ltd

dark coating is very permanent, and with ordinary use does not need renewing for very many years.

There are several processes used by different firms for the treatment of various classes of iron or steel. Broadly, the processes are alike in these respects: that before chemical treatment the metal must be completely freed from grease, and must not

be touched with the hand or any woollen or greasy cloth until the work is finished; that, after de-greasing, the work must be washed, then the solution applied and the metal permitted to rust. Finally the loose rust is rubbed off and the surface oiled with boiled linseed oil.

When a barrel is to be blued, the two ends are plugged with wooden plugs to keep the solution out of the bore and to provide means of lifting without touching the metal-work. Grease is removed by boiling in an alkaline solution in a sheet-iron tank. Then the barrel is washed in clean water in a second tank to remove the alkali, and heated in boiling water in a third tank.

When the metal is hot, the blueing solution is applied with a perfectly clean cotton swab and the barrel set aside for about twenty-four hours, by which time a fine, dull surface of rust will have developed. This is wiped off with a clean cotton rag and the process repeated as many times as considered necessary, according to the method employed and the quality of the steel. Finally, when a rich dark-brown colour has been produced, all solution is removed by boiling in clean water. The barrel is then dried by gently wiping with a cloth, and finished by the application of linseed oil. This has the effect of changing the colour from brown to blue-black.

Small parts can be blued by one of the rusting processes if they are exposed to wear, but screws and other small parts which are not likely to get rubbed are often blued by heating. Oil-blacking and blazing-off are effected by heating the part, dipping it in oil, draining, and burning off the oil that remains. Such processes produce a good colour, but the thin film of oxide will not stand much wear.

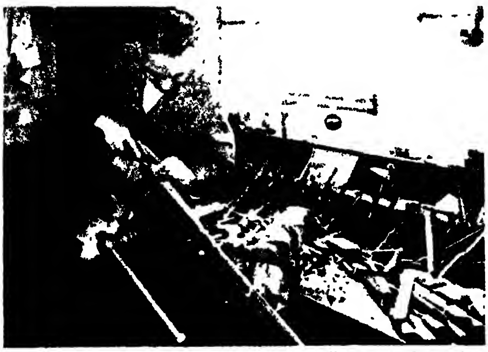
Stock Making

The traditional material for gunstocks is walnut, the best of which for gun-stocking comes from a region in the south of France and the adjacent part of Italy. English gunsmiths use French walnut for all except the lowest-priced guns, and select the very finest figured wood for their best guns. They season the blanks for many years before they are used, weigh them individually at intervals so as to ascertain which are still losing weight by evaporation, and sort them for weight; for the lightest are reserved for very light guns, and those of more dense wood for comparatively heavy guns and rifles.

A gunstock should be selected for strength and beauty. The grain of a one-piece rifle-stock should run parallel with the underside of the butt, continue through the hand and into the fore-end: on no account should there be any cross-grain in the hand, where the greatest strength is required. The butt of a two-piece

[By courtesy of Messrs. Holland & Holland, Ltd.

FIG. 52.—BLANKS FOR STOCKS.



[By courtesy of Messrs. Holland & Holland, Ltd.

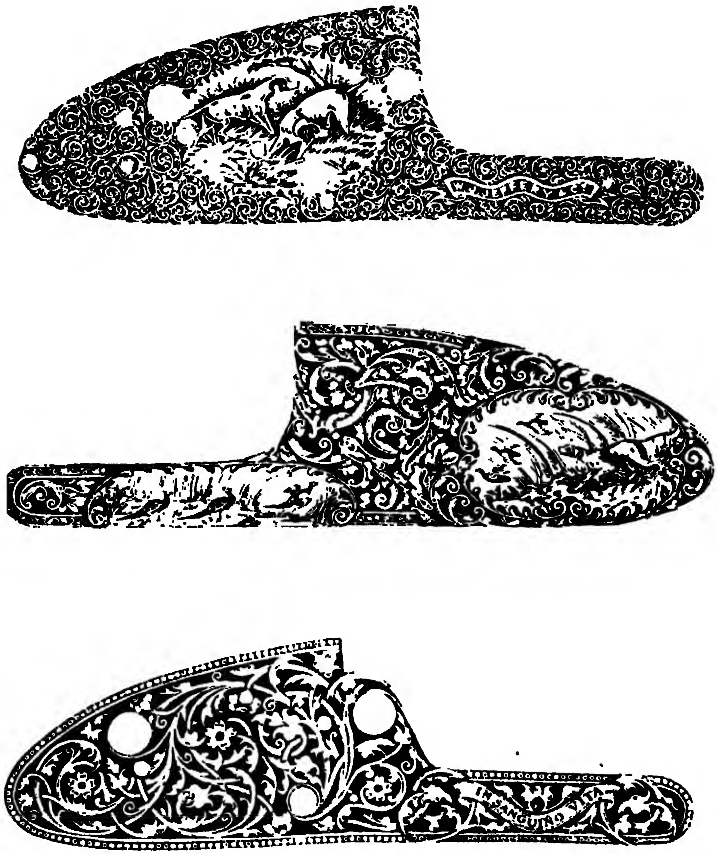
FIG. 53.—STRIPPING AND POLISHING THE STEELWORK PREPARATORY TO ENGRAVING.

stock should also have its grain running straight through the hand, any curl in the grain being towards the rear.

In mass production, rifle stocks are made on copying lathes. Each stock is rotated at the same speed as an iron dummy which has the shape of the finished article. Over the surface of the dummy runs a wheel which is so attached to a revolving cutter

that the latter carves the wood of the stock to the shape of the dummy. Inletting to take the action is also machine work. This reduces hand-work to a minimum.

Good-quality gunstocks are almost entirely hand made, from



[*By courtesy of Messrs. W. J. Jeffery & Co., Ltd.*

FIG. 54.—EXAMPLES OF ENGRAVING.

the initial shaping of the blank, the inletting and fitting of the metal-work, to the final polishing and checkering.

The first stage in the hand making of a one-piece rifle stock is the inletting of the action. This is very careful work, done with sharp tools, and should be made to a perfect fit, lamp-black being

applied to the metal parts to be inserted, and the wood being cut away bit by bit so as to take them exactly. The black marks left by the lamp-black shows the points which are high and which must be trimmed down across the grain. The channel for the barrel is cut slightly undersize to true half-circle, and then worked away at the top edges with the greatest care until the barrel is resting in the bottom of the channel and is in the wood to nearly, but not quite half its depth. Then the bottom is worked away with a very sharp chisel applied across the grain. The barrel is coated with lamp-black and tried in the groove frequently until black shows on both bottom and sides. Then the centre only of the channel is cut down until the entire surface of the channel is darkened by lamp-black. The tool-marks are then removed with fine sandpaper wrapped round a mandrel, care being taken not to damage the edges of the groove.

After inletting, the blanks are hand shaped mainly with the aid of a half-round rasp of about 12 inches in length, the round side of the rasp being used to remove surplus wood and the flat side for shaping. When this is done, butt plate or recoil pad is fitted before final shaping with a fine rasp or cabinet file.

Finishing

After a stock has been brought to its final shape it is smoothed off with sandpaper, firstly of medium, then of finer grade, applied in the direction of the grain. This makes the wood apparently smooth, but does not leave it in the condition in which it will take a fine polish. The secret of polishing is the removal of the loose fibres that are mashed into the wood by the sandpapering, but which can be got rid of by the following process. The wood is moistened with a cloth, the surplus water wiped off and then the surface dried quickly by applied heat sufficient to steam off the water but not to burn. Care should be taken not to scorch any sharp edges. This quick drying raises the loose fibres, which can then be taken off by light application of the finest abrasive paper.

When all tool and sandpaper scratches have been removed and the process of moistening, drying and sandpapering has been repeated until there are no more loose fibres, oil polishing can be started. The first stage of this is to apply raw linseed oil, together with any desired colouring matter, to the dry surface of the wood

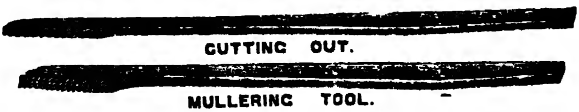
and leave it for a week or so to soak into the grain and oxidise at the surface. At this stage of the process, if more oil is applied it will soak in and darken the grain too much, but if the first coat is allowed to oxidise, it will fill the surface of the wood. If the wood is very soft and porous, it may be necessary to use a mixture of linseed oil and a suitable varnish to prevent further penetration.

The next stage is to apply a little raw linseed oil and, after leaving it for about an hour, to rub the surface of the stock with the palm of the hand for about a quarter of an hour. This should be repeated on several successive days, then the stock re-oiled and set aside to allow the final coat of oil to oxidise. When the oil is thoroughly dry and oxidised, the wood can be polished with a rubbing stick—a batten with leather glued on one side.

CHECKERING

High-quality gunstocks are checkered by hand on the fore-end and the hand—the two places where the rifle is held and there is a practical advantage in a non-slip surface. If well executed, checkering adds greatly to the appearance of a gun or rifle, but it is not essential for practical purposes, and unless well done is best omitted. This work is always done *after* polishing.

The patterns most frequently seen on gunstocks are those which have outlines consisting of straight lines terminating with



By courtesy of Messrs. Parker-Hale, Ltd.

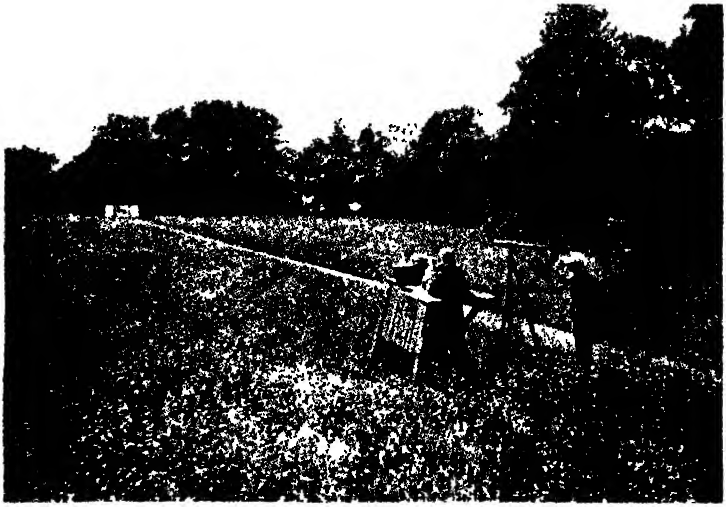
FIG. 55.—CHECKERING TOOLS.

points, the angles of which are equal to the angles of the diamonds of the checkering. These patterns need have no special border line, for the ordinary cuts frame the pattern; but if there are border lines, the lines of the checkering should be truly parallel with them and should in no place tail off into them at an acute angle. The outlines of these patterns are set out with cotton, which is stretched between pins set at the points and tapped into the wood, leaving a mark.

When a pattern with curved outline is desired, the outline is

drawn with compasses. But the first two diagonals of the checkering have to be set out in the same manner as a pointed pattern, from a point on the centre line at an angle one to the other that will be the acute angle of a diamond shape of suitable proportions. A diamond about two and a quarter to three times as long as it is wide is considered attractive. Then the first cut is made.

The cutting tool is a flat strip of metal with teeth at the end. It is held in the hand with the forefinger along the right side and



[*By courtesy of Messrs. Holland & Holland, Ltd.*

FIG. 56.—REGULATING A RIFLE ON THE RANGE.

the thumb pressing gently on top, and it is applied with a backwards and forwards motion, slowly progressing forward along the line to be cut. Very little pressure is applied and the first cut is made very lightly, for if the tool rides up out of the groove that it is making the damage caused by a deep cut out of line cannot easily be filed out.

When the first two diagonals have been made, the parallels are cut similarly and very lightly. For this purpose the tool used cuts two lines simultaneously; one row of teeth runs in and deepens the line previously cut, which acts as a guide to the tool in cutting the next. In this manner a series of parallel lines

are made over the whole face of the pattern in one direction. They are purposely cut as shallow as practicable, for apart from the danger of making an ineradicable error, if one set of lines were to be cut too deep they would obliterate the guide-line for making the opposite diagonals.

When both sets of diagonals have been cut, the pattern is deepened stage by stage with a single V tool. During the whole of the procedure wood dust is removed from the grooves by a stiff brush slightly coated with linseed oil applied vigorously. The final border line can be made with a mullering tool, which leaves a rounded bead edge.

On completion, the checkering is oiled with linseed oil in sufficient quantity to darken the wood, but any excess of oil is brushed out of the grooves, where otherwise it might produce a gummy residue spoiling the appearance of the work.

CHAPTER XIII

THE PROVING OF GUNS

THE Gunmakers is one of the youngest of the City Livery Companies, for it was not until 1637, when most of the craft-guilds had been founded, that the gunmakers applied for a charter. At this time gunmaking was an established trade in the City of London and, to use the words of the charter:

"WHEREAS we have bene informed by the humble petition of our welbeloved Subjects the Gunmakers in and about our Citty of London, that they for many yeares having lawfully practiced and upheld the manufacture of making all sorts of Handgunns as well for our speciall service in supplying our Stores with the Ammunition as for the frequent occasions of our Subjects in their exercises and Musters both for horse and foote both which they are able fully to furnish, and that they having of late yeares attayned more exquisite skill in that Mistery than in former tymes, that nowe divers Blacksmithes and others inexperte in the Arte of Gunmaking have taken upon them to make try and prove Gunnes after their unskilfull way, whereby the said petitioners are not only much damnifyed in their particular trade and livelyhood, but much harme and daunger through such unskilfulness in that Misterie hath happened to sondry of our loyall Subjects; for the reformation of which said evill and abuses now commonly practiced in that Trade, and for the better upholding the said Arte within the Kingdome They have humbly besought us to incorporate them into a Body Politique, and to invest them with such Graunts, priviledges and Powers as may be meete for the same. . . ."

This charter, granted on 14th March, 1637, included the rights of search, view, gage, proof, trial and marking of all hand-guns, great and small, dags (heavy pistols) and pistols in London or the suburbs or within ten miles radius.

Not having an official Proof House was deemed by the Birmingham gunsmiths to set the important gun trade of Birmingham at a disadvantage, and as a result of vigorous representation on their part the Gun Barrel Proof Act of 1813 established a body

entitled "The Guardians, Trustees and Wardens of the Gun Barrel Proof House of the Town of Birmingham for the purpose of proving or causing to be proved . . . all Barrels for Guns, Fowling Pieces, Blunderbusses, Pistoles, and every other Description of Fire Arms which shall be brought to the proofe House at Birmingham, to be proved according to the Provisions of this Act".

Thus, the Worshipful Company of Gunmakers and the Guardians of the Birmingham Proof House became the bodies charged by Parliament with the duty of proving firearms to ensure that they are safe before they may be offered for sale. Further Acts of 1815, 1855, 1868 and altered and strengthened these powers. The Gun Barrel Proof Act of 1868 is, in the main, the current Act, and applies to England and Wales in full and Scotland and Northern Ireland in part. Certain provisions of this Act have been revised by the Act of which permits increase of the authorised maximum prices for proof.

The Act of 1868 applies to barrels of bore not exceeding 2 inches or adapted for the discharge of ball weighing not more than 1¾ lb. But it makes it an offence to sell, exchange, pawn or export any other small arm or barrel that has not been proved by the Proof House or branch Proof House of either of the "Two Companies" or other public Proof House established by law. The Act does not extend to compel the proving of any military barrel made for the forces while it remains the property of the Crown, nor any such barrel after it has ceased to belong to the Crown, provided that it bears, in addition to a Government proof mark, the letter S struck (prior to such cessor) over or upon the Broad Arrow. Under the original Rules (now repealed) if a barrel, after it ceased to belong to the Crown, did not bear the letter S but bore the letter O, the Act compelled definitive proof only in the case of a rifled barrel. It is understood that now the Ministry of Supply does not mark S or O on arms disposed of by them.

The Act requires also that when small arms are imported, notice of their arrival must be given in writing to the Proof Master of each of the Two Companies within seven days, and within twenty-eight days the arms must be sent for proof to the Proof House of one of the Two Companies. However, a barrel of foreign manufacture which bears the requisite proof marks of any foreign proof house that have been entered in the Register of

Foreign Proof Marks kept at the Proof House of both of the Two Companies is exempted from the provisions of the Act unless the barrel or small arm has any mark indicating or purporting to indicate that some part of it is of English manufacture.

Provisional and Definitive Proof

A First and Second, or Provisional and Definitive Proof respectively, were established. The provisional proof serves the purpose of ascertaining that a barrel is sound before the gunmaker expends too much labour on what might prove to be faulty material. For this proof the barrel is fitted with a screw plug having a touch-hole at the breech end, and the proof charge is fired by a trail of powder.

The definitive proof is applied to weapons finished "in the white"—*i.e.* all work likely to weaken the structure must be complete but the metal parts may be bright, not having been blued.

On the general use of nitro powders, which produced more severe breech pressures than black powder, an additional *Nitro Proof* had to be introduced. This was at first optional; but the definitive proof with a new type of black powder remained because the nitro powder of the time, while it caused severe breech pressures, did not adequately test the barrel except in the region of the breech.

Validity of Proof Marks

Up to the present a proof mark remains valid indefinitely even if the weapon is old and reduced in strength by fair wear and tear. But if any barrel marked as proved should otherwise be unduly reduced in strength—*i.e.* by enlargement of the bore—or should the proof marks be removed or defaced, the barrel becomes unproved. Should an old weapon be sent for re-proof and fail to pass the test, the proof marks will be removed, so that all shall know that the weapon is unproved.

The boring or lapping out of old shotgun barrels to remove pitting or irregularities may amount to an enlargement to beyond gauge size rendering the barrels unproved at law. The comparatively recent development of processes whereby metal may be deposited electrolytically on the interior surface of barrels so as to restore the gauge size set up a problem, because such electrolytically deposited metal cannot be expected to have the same strength

and ductility as metal in wrought form. For this reason the Two Companies have ruled that barrels treated in such a manner must be deemed unproved barrels; and they require that such barrels shall be submitted for re-proof, and on submission they must be declared to have been so processed.

Guns Proved for Black Powder

As old proof marks are still valid, whereas there have been changes in types of ammunition available, and consequently in the standards of proving guns, there is a serious danger of old guns proved for black powder bursting on being used with modern cartridges. Guns proved for black powder only *can* be perfectly sound and safe for use with modern nitro powders, but there is no guarantee that they are; and, in fact, such old guns may be extremely dangerous; for, in addition to having been proved to a lower standard than now required, they may have been weakened by age, neglect or misuse. Any English gun not bearing the Nitro Proof mark is almost certainly proved for black powder only, and more than fifty years old. The owner of such a gun is therefore strongly advised to send it to a firm for preparation in accordance with the rules of proof and submission for Nitro Proof.

In view of this danger, the Worshipful Company of Gunmakers, the Guardians of the Birmingham Proof House, and the Gunmakers' Association (Incorporated 1912) Ltd. in a memorandum dated 4th February, recommended, *inter alia*, that:

> "A gun may through neglect or misuse become unsafe in a short time and a gun made over fifty years ago may be extremely dangerous. Shooters are therefore urged most strongly not to buy any gun not bearing the NITRO PROOF marks and not to permit the continued use of any such gun already in their possession until it has passed nitro proof."

The Rules, Regulations and Scales of Proof

Attached to the Act of 1868 were certain Schedules, of which Schedule B, which classified small arms and laid down the rules of proof applicable to each class, was capable of being repealed or altered by the Two Companies on application to, and with the approval of, His Majesty's Principal Secretary of State for the War Department. The last amendment is that of 1921, but new rules are now being prepared.

There are the Provisional or First Proof applied to those barrels which, according to the Rules, require two proofs ; the Definitive Proof, which is applied to all barrels; and a Voluntary Proof, which may be applied after the Definitive Proof on request in writing to cover any declared service load.

According to the Rules of Proof of 1921, the barrels of single-barrelled muzzle-loading smooth-bore guns, breech-loading rifles, including military and other rifles chambered to take military small arm cartridges, revolvers and repeating pistols are proved once definitively; although breech-loading rifles other than military rifles may be proved provisionally. Barrels for double-barrelled muzzle-loading guns, muzzle-loading rifled arms, breech-loading smooth-bore guns, and breech-loading rifled or partly rifled arms constructed for use with shot and bullet are proved provisionally and definitively, except that, on request in writing, double-barrelled muzzle-loading guns and muzzle-loading rifled arms may be definitively proved once only, but according to the scale for provisional proof, and that punt guns and similar guns of not less than 5 feet 6 inches length are proved once only.

Military arms are proved once definitively, the charge being such as will give a stress of not less than 30, or more than 45 per cent. over that of the service charge. Military arms are marked with a special proof mark.

Submitting Arms for Proof

Anyone can submit an arm for proof direct to either of the Proof Houses: the writer has taken a ·22 rifle to the London Proof House and waited while it was proved. But generally it is recommended that arms should be submitted through a gun-maker. This is because the Rules of Proof 1921 lay down how arms shall be prepared for proof before submission; for example, shotgun barrels must be freed from bulges and dents and from pitting as far as practicable, and their actions must be tight on the face. It is also advisable for stocks to be removed, for the Proof Houses will accept no responsibility for damage to them resulting from proof.

The Proof Marks

The various proof marks of the Worshipful Company of Gun-makers and the Guardians of the Birmingham Proof House as set

out in The Rules, Regulations and Scales, Applicable to the Proof of Small Arms, 1921, are as follows:

LONDON PROOF HOUSE

On arms of English manufacture.

Pro-visional	DEFINITIVE Proof	View	Nitro	Military	Re-Proof	Special
1	2	3	4	5	6	7

On arms of foreign manufacture.

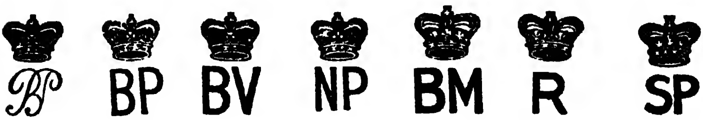
1 2 3 4 5

and, in addition, the words "NOT ENGLISH MAKE."

BIRMINGHAM PROOF HOUSE

On arms of English manufacture.

Pro-visional	DEFINITIVE Proof	View	Nitro	Military	Re-Proof	Special
1	2	3	4	5	6	7



On arms of foreign manufacture.

1 2 3 4 5

and, in addition, the words "NOT ENGLISH MAKE."

The following marks of the Birmingham Proof House, which were in use prior to 1st August, 1904, are still legal.

1 2 3 4

The Provisional Proof Mark is impressed near the breech end of the barrel.

The Definitive Proof and View Marks are impressed on the round near the breech end of single-barrelled muzzle-loading smooth-bores; and above the Provisional Proof Mark of muzzle-loading double-barrelled smooth-bores and all muzzle-loading rifles. Also, if the barrel is constructed with a patent breech, the View Mark is impressed thereon. If these are proved once only, the Definitive Proof Mark is impressed in the same position as the View Mark would occupy.

The Definitive Proof Marks and View Marks are impressed near the Provisional Proof Mark, and the View Mark is impressed upon the action body, shoe, breech-block, bolt or chamber of single breech-loading smooth-bores and rifles other than military arms.

The Definitive Proof Mark and View Mark are impressed on the flat of each barrel at the breech end or in a corresponding position where there are no flats (or on request in writing on the round of each barrel), and the View Mark is impressed on the action body, shoe, breech-blocks, bolts and chambers of double breech-loading smooth-bores and rifles other than military rifles.

The Definitive Proof Mark and View Mark are impressed on the barrel of repeating pistols and revolvers and cylinder of revolvers, and the View Mark on the action body, shoe, breech-block and bolt of repeating pistols.

The Special Definitive Proof Mark for military arms is impressed on the barrel, action, bolt or breech block.

The nominal size of the bore is impressed on the barrels of all arms except revolvers and pistols at Definitive Proof as number of balls to the pound, decimals of an inch, or millimetres, as may be most suitable. The length of cartridge is impressed following the Definitive Proof Mark on barrels of breech-loading arms. The work **CHOKE** is impressed on smooth-bore guns which are choke-bored.

The nominal size of cartridge is impressed near the Definitive Proof Mark, followed by the weights in grains of powder and bullet on breech-loading rifles declared for use with black powder only. The nominal size of cartridge is impressed, followed by the Nitro Proof Mark, the name of the powder used in proof and the weights in grains of powder and bullet of the maximum service charge and the abbreviation **MAX.** on breech-loading rifles declared for use with nitro powders other than those used with military ammunition or to be used with shot and bullet. Rifles, other than military rifles, chambered to take a military cartridge have the Nitro Proof Mark followed by the words **NITRO PROVED** on the barrel. Rifles intended for use with shot and bullet are marked **S & B** following the Definitive Proof Mark or chamber mark if rifled full length, or **R CHOKE** if having a rifled choke only.

Breech-loading smooth-bores and rifled arms for use with shot and bullet are marked with the words Nitro Proof followed by the maximum service charge of shot to be used, thus :

NITRO PROOF $1\frac{1}{8}$

Breech-loading rifled arms constructed for use with shot and bullet, and which are intended to be used with nitro powders when used with ball, are impressed with the same marks of proof as breech-loading rifles declared for nitro powder, followed by the name of powder used in proof, the maximum weights in grains of powder and bullet, and the abbreviation **MAX.**

Other Marks on Military Arms

The following marks which may be found on service rifles are of interest to owners or users, **but have nothing to do with the Proof Houses.**

***** on front of Nock's form means " rust or cut inside barrel ";

on other positions of the barrel means " corrosion or rust on exterior of barrel near the star ";

and on left side of Nock's form at front end of reinforce for muzzle and rear end for breech means " Cord worn. Insp. Dept. marking ".

⊛	ditto, A.O.D. marking.
R	on Nock's form means "found rusty by Examiner and to be cleaned by Armourer".
H.V.	on barrel in rear of backsight means "suitable for Mk. VII ammunition".
T	on left side of bed backsight means "bed side backsight fixed by a tapered pin".
E.Y.	on Nock's form means "may be utilised in case of emergency".
D.P.	on Nock's form means "for drill purposes".

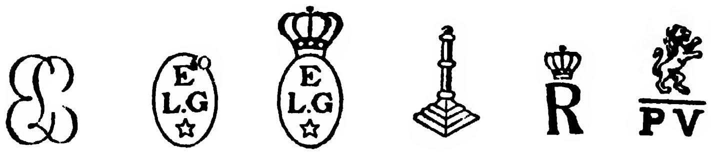
Foreign Proof Marks

The Proof Marks of Belgium, France, Italy and Spain are recognised in England by reciprocal agreement, and arms bearing the appropriate marks of these countries are not required to be re-proved. Up to 22nd May, 1916, German and Austrian Proof Marks were recognised, but this is no longer the case, and all arms bearing German or Austrian Proof Marks only are now considered "unproved arms", even though they may have been purchased prior to the above-mentioned date.

BELGIAN PROOF MARKS

THE LIEGE PROOF HOUSE

Provisional	Former Definitive	Definitive	View	Rifling	Nitro
1	2	3	4	5	6



PROVISIONAL

Foreign	Double Proof	Triple Proof
7	8	9

Single Muzzle-loading Shotguns must bear the marks 1, 2 and 4, or 1, 3 and 4 upon the barrel and 4 upon the breech.

DOUBLE MUZZLE-LOADING SHOTGUNS must bear the marks 1, 2 and 4 or 1, 3 and 4 upon the barrel and 4 upon the breech.

SINGLE BREECH-LOADING SHOTGUNS must bear the marks 1 (or 8 or 9) and 3 upon the barrel and 4 upon the lumps and the action.

DOUBLE BREECH-LOADING SHOTGUNS must bear the marks 1 (or 8 or 9) and 3 upon the barrel and 4 upon the lumps and the action.

CHOKE-BORED GUNS must bear, near the gauge-marks, the word "Choke", and if rifled in the choked part of the bore "Ch. B. Rayé".

SINGLE AND DOUBLE RIFLES (except rifled choke) must bear the marks 1 (or 8 or 9) (and when submitted to Provisional Proof), 3 and 5 upon the barrel, and 4 upon the lumps (if lumps exist) and the action or principle parts of the action. (Art. 29 and 30).

BREECH-LOADING PISTOLS, SMOOTH BORE, of calibre 12 mm. and larger, must bear the same marks as single and double breech-loading shotguns.

BREECH-LOADING PISTOLS, SMOOTH BORE, of calibre under 12 mm., must bear the marks 3 and 4 upon the barrel and 4 on the action.

RIFLED BREECH-LOADING PISTOLS must bear the marks 3, 4 and 5 upon the barrel and 4 upon the action.

MUZZLE-LOADING PISTOLS must bear the marks 2 or 3 and 4 upon the barrels and 4 upon the breech.

REVOLVERS must bear the marks 3 upon the cylinder, and when rifled 5 upon the barrel. REPEATING PISTOLS must bear the marks 3 and 6 upon the barrel and 6 upon the action.

SMALL BORE GUNS, RIFLES AND PISTOLS (called "Carabines Floberts" and "Pistolets Floberts") of the following bores—viz. ·22 in., 7 mm., 8 mm., 9 mm.—must bear the marks 3 and 4, and if rifled 3, 4 and 5 upon the barrel and 4 upon the action.

IMPORTANT.—Breech-loading Arms of any description proved for use with Nitro Powders bear the mark 6 upon the barrel and action, in addition to any other marks applicable thereto.

The exceptions to the above are as follows :

MILITARY RIFLES in which nitro powder is used must bear the marks 3, 5 and 6 upon the barrel and 4 and 6 upon the action or principal parts of the action.

On arms other than of Belgian manufacture the mark 7 is used in lieu of mark 3.

On barrels with solid lumps the mark 4 does not appear.

There are other marks used, but they are always in addition to the above-mentioned.

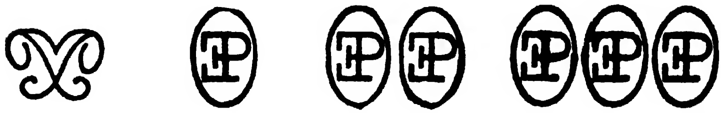
FRENCH PROOF MARKS

THE PROOF HOUSE OF THE PARIS CHAMBER OF COMMERCE

Provisional Proof 1

Finished Barrels with Actions

Ordinary Proof 2 — **Double Proof** 3 — **Triple Proof** 4



Black Powder

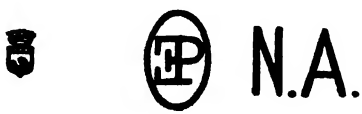
Ordinary Proof 5 — **Superior Proof** 6

Smokeless Powder " T "

Ordinary Proof 7 — **Superior Proof** 8

Supplementary Proof 9 — **Normal Sized Arms** 10 — **Foreign Made Arms** 11 — **Rifled Arms (long)** 12

Short Barrelled Arms 13 — **Complete but not assembled Arms** 14



THE PROOF HOUSE OF THE SAINT ETIENNE CHAMBER OF COMMERCE

Provisional Proof 1

Finished Barrels with Actions
Ordinary Proof 2
Double Proof 3

Finished Barrels with Actions Triple Proof 4

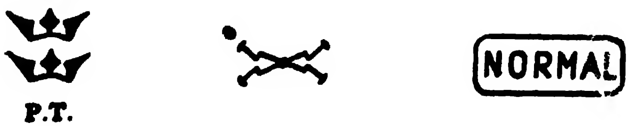
Black Powder . Ordinary Proof 5 | Superior Proof 6

Smokeless Powder 'T' Ordinary Proof 7

Smokeless Powder 'T' Superior Proof 8

Supplementary Proof 9

Normal Sized Arms 10



Foreign Made Arms 11

Rifled Arms (long) 12

Short Barrelled Arms 13

Complete but not Assembled Arms 14

Mark 1 is a Provisional Proof Mark stamped on tubes which are intended to be subject to further manufacturing processes; and, having no legal significance, is for the convenience of the manufacturer (cf. London and Birmingham Provisional Proof Marks). Marks 10 and 11 are used only in certain cases and are not marks indicating proof.

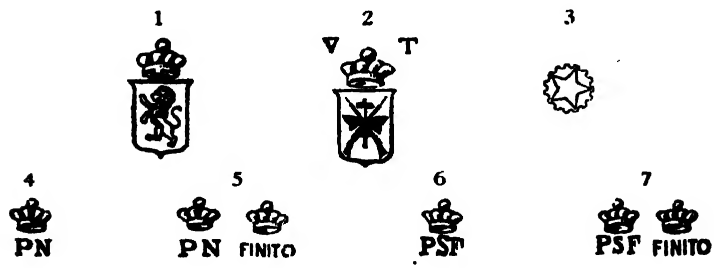
As the proof of Small Arms in France is optional, the Gunmakers Company of London and the Guardians of the Birmingham Proof House give notice that they do not consider any Smooth Bore Arm of French manufacture sufficiently proved unless it bears at least the undermentioned marks.

All Smooth Bore Small Arms (except double guns proved prior to the welding together of the barrels), must bear on the barrel, one of Marks 2, 3 or 4 and, on both the barrel and the action, one of Marks 5, 6, 7 or 8. If the Arm, on submission to proof, is not "in the white", it should bear also Mark 9. A double gun, which has been proved prior to the welding together of the barrels, will not bear any of these Marks 2, 3 or 4, but will bear in lieu of any one of those Marks the following, namely:—In substitution for Mark 2, Mark 14 (that is to say, Mark 2 with the letters "NA", after the monogram EP for a Paris Proof or interposed between the City's Arms and the word "St. Etienne" for a St. Etienne Proof); or similarly, in substitution for Mark 3 or Mark 4 as the case may be a substituted mark similar to 3 or 4, but with the letters "NA" disposed in a similar place as that in Mark 14 in relation to Mark 2.

All long barrelled rifled arms of smaller calibre than ·410 must always bear Mark 12.

All revolvers and automatic pistols must bear Mark 13.

ITALIAN PROOF MARKS



Mark 1 (Brescia) is no longer in use. All marks in use since July, 1910, have mark 3 (the Republic's Star) substituted for the Royal Crown.

Breech-loading Shotguns proved for black powder must bear the marks 1 or 2, and 3, 4 or 5 upon the barrels and 1 or 2 upon the action.

Breech-loading Shotguns proved for nitro powder must bear the marks 6 or 7 in lieu of 4 or 5.

Breech-loading Rifles must bear the marks 1 or 2, and 4 or 6 upon the barrels and 1 or 2 upon the action.

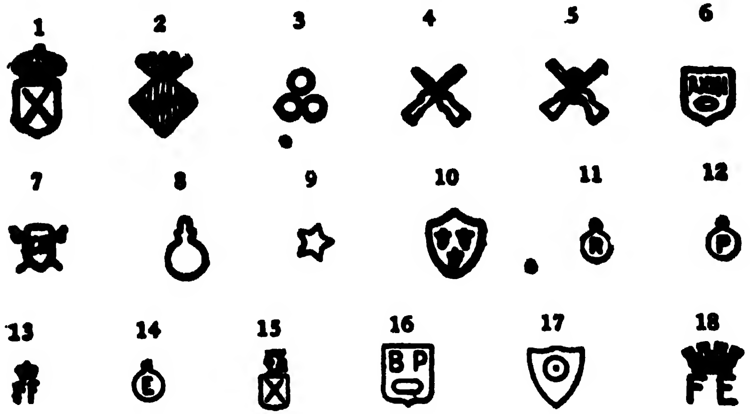
Revolvers and Repeating Pistols must bear the same marks as rifles.

Punt Guns must bear the marks 1 or 2, and 4 upon the barrels and 1 or 2 upon the action.

Choke-bore barrels will be so marked.

There are other marks used, but they are always in addition to the above-mentioned.

SPANISH PROOF MARKS



All arms proved in Spain must bear on each barrel, action flat and action body-mark No. 1 or 2 or (if proved since July 1911) No. 15. Most of such arms must also bear on the barrel No. 13 or (if proved since July 1911) No. 18. In addition, each class must bear the following marks :

Muzzle-loading shotguns must bear No. 3 on each barrel and in the priming nipple.

Breech-loading Shotguns must bear on each barrel, and action flat, marks Nos. 4 and 5, and if proved for ordinary smokeless powder in addition No. 6 or (if proved since July 1911) No. 16. No. 7 may also appear in certain cases.

Breech-loading Rifles (whether automatic or not) must bear Mark No. 8 on the barrel, action body, bolt or breech-block.

Saloon Rifles and Pistols must bear No. 9 on the barrel, action body, bolt or breech-block.

Pistols (not automatic) must bear Mark No. 10 or (if proved since July 1911) No. 17, on the barrel and action body.

Revolvers must bear Mark No. 11 on the barrel, cylinder and action body.

Self-loading or Automatic Pistols must bear No. 12 on the barrel, the slide and action body.

Mark No. 14 denotes the arm is not of Spanish manufacture. All marks of proof since July 1911 are (except where otherwise indicated) of similar pattern but usually of larger size.

The Author is indebted to the Worshipful Company of Gunmakers and the Guardians of the Birmingham Proof House for permission to reproduce from *Notes on the Proof of Gun Barrels* the illustrations and most of the text on pages 169 to 178.

CHAPTER XIV

GUNFITTING

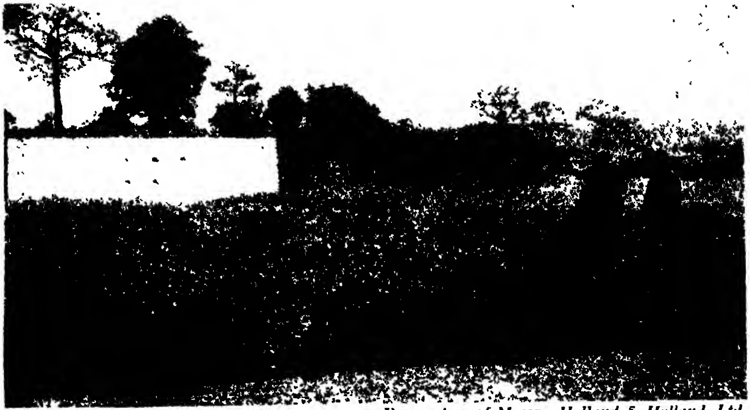
A SHOTGUN is brought up behind the moving target and swung through ahead of the bird so as to allow for the distance that it will fly in the time taken by the shot to reach it. The trigger is pressed without a pause in the swing. The whole action is made in one movement, there being no deliberate aim of the weapon.

The amount of allowance ahead of the bird is learnt by experience. Briefly, it can be said that when a shot is taken at a rising bird, the muzzle blots out the bird at the time the shot is fired : when the bird is falling or going away it must be seen clear above the muzzle if a clean shot kill is to be registered; passing birds are led by an appreciable distance.

The gun is, of course, pointed and in fact sighted, in that the muzzle acts as a foresight, and the eye of the shooter is brought into such a position that, without a backsight, the gun is properly aligned. This accurate positioning of the eye relative to the line of the barrel comes with practice, but is very much affected by the fit of the gun to the individual shooter; and while it has been observed that farmers and gamekeepers often shoot well with ill-fitting guns, the majority of shooters need guns accurately fitted to their requirements. Often the alteration of an incorrectly fitted gun brings bad shooting to an end.

An experienced gunmaker can tell fairly well from the build of his client the measurements of gunstock that will suit him, but for a gun to be properly fitted the shooter should first go to the shooting school and practice with a try gun under the instruction of a gunfitter who will prepare a specification of measurements to which the new gun will be made. Later, when the new gun is " in the white ", it should be taken to the shooting school to be tried out, so that any final adjustments in the shape of the stock may be recommended.

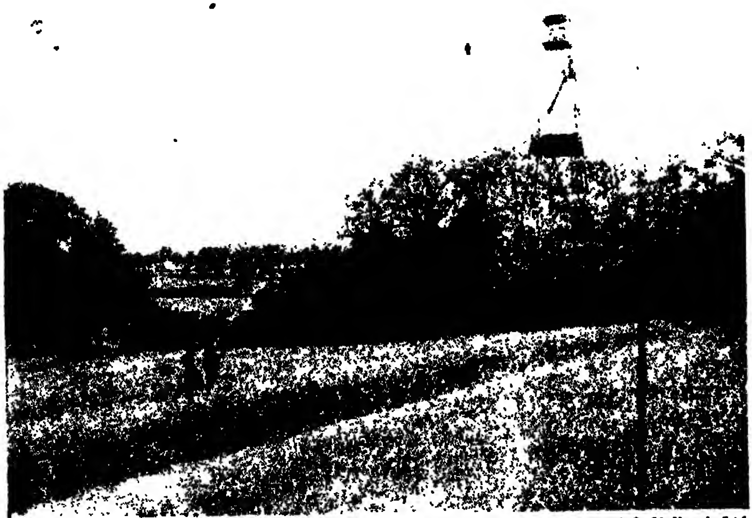
The *try gun* used for ascertaining the measurements of a client is an ordinary shotgun, except that the stock is adjustable for length, cast off, bend and, except in obsolescent models, every useful adjustment of shape. Its measurements can be altered in



[By courtesy of Messrs. Holland & Holland, Ltd.

FIG. 57.—SHOOTING WITH THE TRY GUN AT TARGETS FITTED WITH ARRANGEMENT OF DISAPPEARING BIRDS.

The result of each shot is recorded on the target showing the position of the shot in relation to the bird.



[By courtesy of Messrs. Holland & Holland, Ltd.

FIG. 58.—HIGH TOWER FOR PRACTICE AT "DRIVEN PHEASANTS".

the field until the gunfitter is satisfied that the shooter is accurately fitted. Then the stock is measured and the specification written.

Besides being fitted for accurate shooting, a gunstock should be such that it is not uncomfortable to use and does not unduly bruise the shoulder of the shooter. It should also preserve a clean, normal, gun-like appearance, even when the most extraordinary fitting is found to be necessary.

Measurements of Stock

The most obvious measurement of a stock is the length. This is measured from the front trigger to the heel (or bump), toe and middle of the butt, the last measurement being of most importance (see Fig. 61). If the stock is too long, the gun will come up badly, catching in the shoulder; if it is too short, the recoil may be felt unduly. Length should be determined when the shooter has on the clothes he will wear in the field, particularly if he is in the habit of wearing a thick shooting coat; for stock length is better slightly short than overlong.

(By courtesy of Messrs. Parker-Hale, Ltd.

Fig. 59.—Try Gun.

Average stock length is in the region of from 14 to 14½ inches; but this measurement is more varied than any other, and must be altered according to the reach of the individual.

The distance from trigger to middle of butt should be longer in a shotgun than in a sporting rifle.

The downward *bend* of a stock, necessary to bring the butt to the shoulder when the barrel is in line with the eye, is measured at the comb and heel, the normal measurements being 1½ inches at the comb and 2 inches at the heel, or perhaps a little more, below the line of the top of the barrel (see Fig. 61).

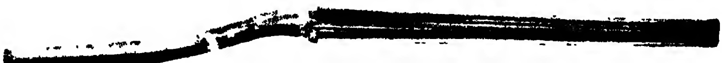
Pitch is the measurement which can best be described as being the distance from the muzzle to the wall when a gun is stood with heel and toe resting on the floor and with the breech touching the

wall. This is not of course the correct way of measuring pitch, which should be accurately done with a special square made for the purpose. Insufficient pitch may cause the butt to slip down from the shoulder.

The normal butt is *cast off*—*i.e.* it is set a little to the right of the line of the barrel. If cast off is insufficient, the right-handed shooter is liable to place his shots to the left of the target. For the same reason left-handed shooters have their stocks *cast on*—*i.e.* set to the left. Very extreme cast off (cross-eyed stock) makes it possible for a shooter to shoot from the right shoulder but sight with the left eye (see Fig. 60). Normal cast off is in the region of $\frac{1}{8}$ inch at the comb and $\frac{1}{4}$ inch at the heel.

The Shooting School

Shooting schools are not only used by gunmakers for ascertaining the measure of their clients and fitting guns accurately: they also serve for the instruction of beginners in the elements of shooting, for the correction of bad habits and other faults in the average shooter, and as before-season practice grounds for experienced game-shooters. Several firms of gunmakers have their own grounds; others make common use of schools by arrangement. In the London area the shooting schools are as near to town as practicable, which mean a distance in the region of 14 miles from the centre of the County.



By courtesy of Messrs. Cogswell & Harrison, Ltd.

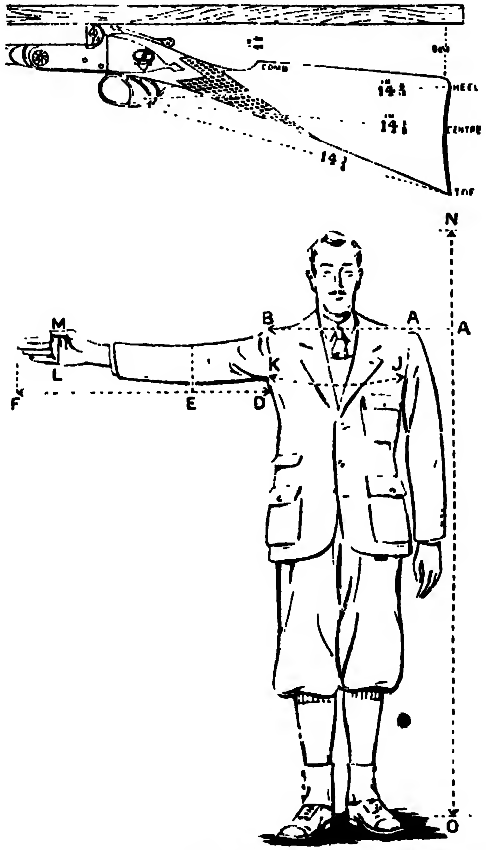
Fig. 60.—Gun with Cross-eyed Stock for Shooting from the Right Shoulder with the Left Eye.

The beginner is first made to shoot at fixed targets and then at figures of birds moved on wires across the faces of large, whitened, iron plates. By this means the gunfitter can see just where the shots are going, and why.

The next stages of shooting are at clay birds thrown from a trap at various angles resembling the flight of birds flushed during walking-up, and at clay birds thrown from behind high hedges

so as to simulate driven partridges. "High pheasants" are thrown from steel-plated towers of 60 feet or more in height.

The fitting of a gun is decided by shooting at the fixed and moving targets before the whitened steel plate, and by the more



[*By courtesy of Messrs. W. W. Greener, Ltd.*

FIG. 61.—*Above*: SHOWING MEASUREMENTS OF STOCK. *Below*: SHOWING PERSONAL MEASUREMENTS USED IN ORDERING GUN.

elementary clay bird shots. The plate shows at once the direction and amount of error, for the shot-marks are visible. Errors of shooting at clay birds can be observed by the gunfitter, who, standing behind the shooter, can *see* where the shots go.

Gun Measurements and Self-measurement

When ordering a gun from overseas, it may be impossible to get gunfitter's measurements. In this case the purchaser could measure his old gun or, if he has no gun which fits him, send the gunmaker a diagram giving his personal measurements, so as to avoid ordering a totally unsuitable gun. Closer adjustments could later be made by a local gunsmith when the gun arrives.

To measure a gun, place it on a table right way up. Take a strip of wood, or any kind of straight-edge sufficiently long, and lay it along the rib of the gun, extending over butt and muzzle. Then take the measurements for bend at heel, and at comb. To measure length of stock: if a hammerless gun, fully cock and put the safety at " ready for firing "; if a hammer gun, fully cock the right lock, and lay the gun right lock uppermost on the table. Then take the measurement from the point where the finger presses the right-hand trigger, to the edge of the butt at three points, bump, centre and toe, and give the measurements as follows:

Bend at heel ....
,, at comb ....
Trigger to bump ....
,, to butt centre ....
,, to toe ....

W. W. Greener Ltd. issue the diagram shown in Fig. 61, and the following questionnaire for the use of sportsmen ordering abroad.

"Fill in the following details clearly and carefully, mention any peculiarity you may have developed in shooting.

....

Do you hold the head erect?.........or do you drop your cheek well forward on the stock?..................................

Do you shoot from the right or left shoulder?..................

Do you aim with right or left eye?..................................

Do you shoot with both eyes open?..............................

Give the following exact measurements taken in your customary shooting clothes, follow the letters marked on the diagram :

A to *B*, width across shoulders..

A to *O*, height from heel to shoulder ....

D to *E*, length under armpit to inside elbow ....

E to *F*, length inside elbow to tip of trigger finger..............

J to *K*, chest measurement, circumference under armpits......

L to *M*, circumference of hand, open..............................

N to *O*, total height..

Weight ....

In the case of a left-hand shooter, the measures of the left arm and hand should be given.

State whether half-pistol hand or straight-hand stock is required ...."

CHAPTER XV

CLEANING AND MAINTENANCE

THE perfection of an accurate rifle can be ruined in a matter of hours if the bore is not cleaned the same day as it is used with corrosive ammunition. Continued neglect of this kind will very soon render a rifle unserviceable. Similarly it does not take long for rust to spoil the pattern if a good shotgun is neglected. Keeping the barrel of rifle or gun clean and free from rust is the first and most important item of maintenance.

Cleaning was of less importance in the days of black powder, particularly before the invention of corrosive cap compositions. Black powder fouled the barrels, leaving a heavier and less easily removed deposit than modern nitro powders. This had to be removed frequently for the sake of accuracy and for the best results after each shot; but severe barrel corrosion did not arise until cap compositions containing potassium chlorate were used in conjunction with nitro powders.

When this combination was used, it was found that rusting of the bore could start several days after what was considered a thorough cleaning. At first it was thought that the nitro powders were to blame, but eventually it was discovered that "after rusting" was due to the deposition of potassium chloride produced by the combustion of the potassium chlorate content of the cap composition.

Modern non-corrosive cap compositions have done away with the danger of after rusting, and the residue of a burnt modern cap composition is, in fact, protective to the bore if present in sufficient quantity.

Thus there are three conditions that have to be considered and three methods of cleaning: weapons using corrosive ammunition must be water-cleaned to dissolve out the potassium chloride; those using non-corrosive ammunition need only cleaning out and then oiling to protect them from the damp; rim-fire rifles need not be cleaned or oiled unless being put away for a long time.

Cleaning Equipment

The best implement for cleaning the barrel of a rifle or shotgun is a cleaning-rod of the correct size, preferably in one piece, and celluloid covered so that no damage is caused to the bore. Screw-jointed rods are very handy when travelling, but a one-piece rod should always be kept in the gun cupboard for regular use.

At the handle end is either a ring or a ball-bearing handle, the choice of which is a matter of individual preference, for each can be used efficiently. The ball-bearing type is made to permit the rotation of the rod in accordance with the rifling : the ring type, which is cheaper, has the advantage that it makes it possible for flannelette patches to be screwed into the chamber which prevents them from rucking up and jamming.

At the other end is a screw thread to which are fixed the various cleaning brushes and jags round which flannelette patches are wrapped.

There are two kinds of patches : the disc type (for ·22 calibre only), which are placed over the end of a cleaning plug; and the oblong type, which are wrapped tightly round a jag (known in America as the long contact jag): the latter is to be preferred. For the jag and patch to enter the barrel easily, the patch should be evenly and tightly rolled round the jag (like rolling an umbrella), with no wrinkles or loose ends.

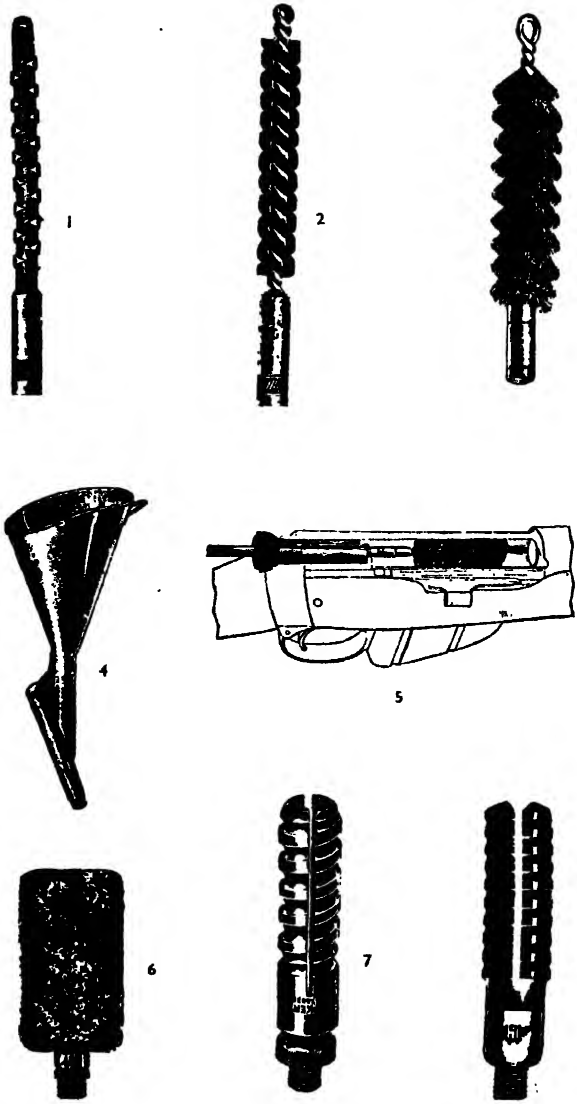
If possible, the rifle should be cleaned from the breech end and the patch passed through the barrel just far enough to reach, but not extend from, the muzzle. Cleaning-rod stops which clamp on the rod are available to prevent the rod from going too far.

Hardwood guides made in different patterns for P.'14 and Lee Enfield rifles give protection to cleaning-rods, and in some cases prevent dirt from the barrel entering the action. They are inserted from the rear after the bolt has been withdrawn.

Cleaning by Pull-through

The use of a pull-through for cleaning a rifle is normal on active service, because a pull-through is so much more easily carried by a soldier than any form of cleaning-rod. But pull-throughs are not used much by rifle enthusiasts because they have to be used much more carefully to avoid muzzle wear by the cord.

In military practice the weight of the pull-through is always put



[*By courtesy of Messrs. Parker-Hale, Ltd.*

FIG. 62.—CLEANING EQUIPMENT.

1. Jag. 2. Wire Brush. 3. Barrel Scourer. 4. Funnel for Hot-water Cleaning. 5. Slotted Guide for Use when Cleaning Lee-Enfield Rifle. 6. Wool Mop. 7. Special Gun Tow Jag. 8. Flexible Horn Jag for Shotgun.

in at the breech and lowered until it appears at the muzzle. A piece of 4-inch by 2-inch flannelette is passed through the centre loop of the pull-through cord and pulled through, care being taken to prevent the cord from rubbing against the inside of the muzzle, as this would eventually cause bellmouth.

There are three loops on the cord: that nearest the weight is for the wire gauze on the rare occasions that it is used, the middle loop for the flannelette for ordinary cleaning, and the end loop for pulling back the cord should it break in the barrel.

Cleaning is done first with dry flannelette before the chamber is cleaned out with a chamber-stick with a piece of flannelette fitted in the slot at its end and wound round it. The chamber-stick is rotated by hand two or three times to clean the chamber.

Next, a slightly oily piece of flannelette is drawn through the barrel two or three times.

The wire gauze is used for removing hard fouling, such as might be caused by neglect. It is rolled in the form of the letter S round each of the two sides of the first loop of the pull-through so as to fit the barrel tightly, and should be well oiled before passing through. The gauze should not be used except when necessary, because it tends to wear the bore.

Pull-throughs of civilian type such as are available for ·22 and other calibres consist of a cord with a weight at one end and a brush of bristle, nylon or phosphor bronze at the other, terminating with a loop to take a flannelette patch. There is no extension for pulling back the cord should it break, and although of course this could be added by attaching to the loop, it is best to inspect the pull-through and discard it as soon as it shows signs of wear, for a cord jammed in the barrel is not too easy to remove.

Cleaning after Corrosive Ammunition

Potassium chloride deposited in the barrel of a rifle or a shotgun can be removed by water either hot or cold and with or without an alkaline content. Hot water is better than cold, because it heats the barrel and makes complete drying easier. Special funnels with swan-necked spouts are used for this purpose. For cleaning a ·22 rifle at least two pints of boiling water should be poured through the barrel; five or six pints are required for a service rifle.

After cleaning with boiling water, the bore should be thoroughly

dried with several heat-dried patches, followed by a patch saturated in Young's "·303" Oil.

After this the rifle should be stood muzzle down, or laid flat, to allow the oil, which contains a volatile component, to thicken. If the rifle is stood with the muzzle upwards the oil will run into the action, where it is not wanted, for it is too thick to use as a lubricant. But if the rifle is laid flat the oil will thicken in the barrel and give more permanent protection than ordinary thin oil, which might eventually run out.

Cleaning after Non-corrosive Central Fire Ammunition

In America, where non-corrosive central fire ammunition is common, it is considered by some authorities that there is no need to put water through the barrel after using non-corrosive ammunition and that it is necessary only to clean and oil up. Cleaning and oiling is essential, because the quantity of cap composition is not sufficient to protect the bore against rusting due to damp. It is advisable to clean the same day as the rifle is fired, by swabbing with a patch saturated with a good powder solvent or gun oil, thoroughly cleaning with dry patches until all fouling is removed, and then, when the bore is quite clean, oiling up with a patch saturated with Young's "·303" Oil or other good gun-oil.

Very few types of non-corrosive central fire ammunition are manufactured in England. The ·22 Hornet made by I.C.I., however, is non-corrosive, and the makers state that "the residue will not cause rust, but an oily rag passed through the barrel will protect it from atmospheric moisture". The Holland and Holland ·240 Apex rimless cartridge is now being manufactured with non-corrosive primer, and it is understood that other calibres, such as the 7 m/m Mauser, will shortly follow. But on the whole it is perhaps safest to advise hot-water cleaning for all rifle barrels except those of ·22 calibre.

To Clean a ·22 Rifle after Using Non-corrosive Ammunition

When non-corrosive ammunition is used, it is not necessary to clean the rifle to prevent corrosion, and the residue from the primer forms a protective coating for the inside of the barrel. But when it is suspected that the rifle is not shooting perfectly,

owing to the presence of lead in the barrel, it should be cleaned by scrubbing vigorously with a phosphor-bronze brush and a little oil, after which flannelette patches should be pushed through the bore until the last one comes out clean. The rifle should then be oiled with an oily patch passed through the barrel three or four times.

Cleaning Revolvers

A revolver requires to be cleaned in more places than the barrel. There are, of course, the chambers of the cylinder, which are not likely to be overlooked, but there is also the front face of the cylinder itself and the adjacent face at the rear of the barrel, and other parts of the frame which the powder may have discoloured. Also the firing pin or the point of the hammer should be cleaned. Finally the whole revolver should be wiped over with an oily wash-leather to remove perspiration which might cause rust.

Webley and Scott recommend that the barrels of ·22 revolvers should not be cleaned if non-rusting ammunition has been used, but that it is advisable to clean and oil the cylinders, the chambers of which do not receive the protection that is given to the barrel by the cap composition. The cylinder should also be taken out occasionally to remove deposits of burnt powder from between the front of the cylinder and the rear of the barrel.

Storage of Rifles

Before putting a rifle away for a long time the bore should be cleaned by the method appropriate to the type of ammunition used and oiled with Young's "·303" Oil or a thick oil, after which muzzle and breech-ends should be sealed with thick grease and a label tied on the action stating that this has been done.

Metallic Fouling

When cupro-nickel was used as a material for bullet-jackets, lumps of metallic fouling formed in barrels, and these had to be removed chemically, with careful precautions against injury of the bore by rust, which would rapidly take place unless air were excluded during the process. Now, the use of gilding metal for jackets has done away with the problem of nickelling, and usually lead is the only metal that has to be removed from a bore. One method of removing lead is to fill the barrel with mercury and then thoroughly clean. A method that has been recommended

for use when mercury is not available is to swab the barrel with blue mercurial ointment, let it stand for some considerable time and then use the brass brush.

Use of Rifled Arms after Cleaning

A rifle or pistol should never be fired after it has been oiled up until the oil or grease has been removed with dry patches. One shot through a heavily greased barrel will split the barrel from end to end, and a shot through a lightly greased barrel may cause a bulge sufficient to ruin accuracy. A patch soaked in petrol is good for getting the grease out.

Cleaning Shotgun Barrels

Immediately after a day's shooting a gun should be wiped down to remove moisture and dirt, and then the barrels taken off for thorough cleaning. The recognised method of cleaning a gun barrel is to use tow twisted round a jag in sufficient quantity to nicely fit the bore, but not so much as to necessitate forcing, with the risk of bulging the barrel. After roughly cleaning through, any leading will be visible as streaky marks near the chamber, and this, if present, can be removed with a wire scratch brush. Finally the bore should be oiled with a mop-head attachment to the cleaning-rod.

The cleaning of guns with tow is a gunsmith's method, very efficient and economical, but requiring practice, for too much tow will jam and injure the barrel, and too little be ineffective. The method recommended by Messrs. Parker-Hale, who supply very complete cleaning outfits, is to scrub out the fouling with a wire brush wetted in Aqueous Solvent made by mixing one part of Young's "·303" Cleaner and Rust Preventer with three parts of water, then to swab out with Aqueous Solvent on a flannelette patch held in a special jag made for the purpose, and repeat until clean. The barrel should then be dried out with a clean flannelette patch, and finally oiled generously with Young's "·303" Oil applied with a wool mop or bristle brush.

The exterior of gun-barrels should be carefully dried and oiled, for rusting is very liable to occur at the join of the ribs with the barrel, and they should be handled with a cloth when this is being done. The main working parts, including the flats, lump loop and ejector cams, should be carefully cleaned and oiled.

Removing Rust

If the bore of a rifle gets rusty, provided the rusting is only light the rust can be removed by softening it with Aqueous Solvent, and brushing vigorously, firstly with a bristle brush and then with a bronze wire brush. If this is not effective, a one-way scourer brush can be used, care being taken that it is not passed out of the end of the barrel, for it cannot be pulled back. If the barrel is pitted, little can be done other than re-barrelling the rifle.

The method of cleaning a rusty shotgun barrel is generally similar. Boiling water will " kill " rust and serve as a temporary measure, but the owner of a pitted gun is recommended to get his gunsmith to deal with it without delay.

Removing Obstructions

The best way of removing an obstruction from a rifle barrel is to apply oil to the barrel from both ends; then, when the oil has soaked into the obstruction, to take a steel bar of almost the size of the bore and having flat ends, and drive out the obstruction with a heavy hammer or mallet. A bar that is much smaller than the bore or has not flat ends should not be used, as it might be driven in to the obstruction, creating a much more difficult problem.

Stoppages in rifle or gun barrels due to patches or other fibrous material becoming tightly wedged, if not easily pushed out, can be removed by picking out piece by piece with a wood screw brazed or welded to the end of a rod.

Barrel Gauging

Gauges for measuring the bore of barrels to find if they are worn, bulged or reduced by metallic fouling are made in sets and vary in diameter by a quarter of a thousandth of an inch. The gauges, which are cylinders of hard steel, are made to screw on to an ordinary cleaning-rod, so that they can be passed through the barrel, when tight or loose places can be located by feel.

A rough-and-ready method often used by riflemen to test the condition of the bore is to pull a lead bullet out of a cartridge and push it steadily through from the breech end after the bore has been thoroughly cleaned. Any irregularity can be easily felt.

Lapping Old Barrels

Old rifle barrels may be lapped to remove rough patches which are causing metallic fouling or to correct diameter; but before a barrel which presumably has been made to correct diameter is lapped, the diameter should be checked by measurement in order that it is not overlarge after lapping.

In the first place, the barrel should be thoroughly cleaned, all metallic fouling being removed, and then it should be oiled lightly with a very thin oil. The diameter is measured by driving through a pure lead bullet turned on a lathe to large size, using a stiff steel rod which nearly fits the bore and has flat ends. The bullet is lubricated, placed in the chamber and forced into the rifling by striking the end of the steel rod lightly with a hammer. When the bullet has gone 1 inch into the rifling, the rod is inserted from the muzzle end and the bullet pushed out. Firstly, groove diameter is measured in several directions across the bullet, and then, after the bullet has been carefully shaved down to bore diameter, this is also measured. Another bullet is similarly pushed through the bore to within 1 inch of the muzzle, set up by striking the rod several times against its base, and then tapped out of the muzzle and similarly measured with a micrometer.

Roughness and irregularity of diameter are detected during this process of pushing the bullet through the bore, for if it is tapped through with a hammer with light even blows, the distance moved per stroke will be reduced where the bore is small or rough; if the bullet can be pushed through by manual pressure, irregularities can be felt.

Measuring or Inspecting Chamber

The easiest way of inspecting or measuring a chamber is by making a sulphur cast which can be withdrawn and examined under the microscope or measured by micrometer.

A mixture is made of sulphur, lamp-black and spirits of camphor in the proportions of 2 oz., three grains and three drops respectively. This mixture is heated while continuously stirred until it becomes fluid.

The chamber is thoroughly cleaned and coated with a thin film of oil, and a cork or other stopper pushed past the chamber into the barrel with a wire stuck through it to act as a handle for the

cast. The melted sulphur mixture is poured in quickly and allowed to cool, after which it is pushed out by inserting a cleaning-rod at the muzzle. Care must be taken not to break the cast, which is brittle.

Sulphur casts shrink slightly but progressively for several hours after they have been made, and should be measured without undue delay.

Testing Trigger Pull

Spring-balance trigger-testers are used by military armourers for finding the weight of triggers to the nearest quarter pound, but the only method of testing trigger pull which is accepted at competitions is by hanging a dead-weight trigger tester on the trigger so that it pulls in the same direction as the trigger is normally pulled by the finger. A dead-weight trigger tester consists of a weight, a cranked arm and a small wheel which rests on the trigger. The weight is placed on the ground and the wheel on the trigger; the rifle is held in the appropriate position to give the correct direction of pull, and lifted very gently. A 3-lb. weight is used for small-bore rifles, and a 5-lb. weight for service rifles. These should not release the trigger when lifted off the ground.

The following method has been used by the writer for accurately determining trigger weight. The rifle is fixed at the correct angle and a bucket suspended from the trigger by a cranked arm. Water is added slowly to the bucket until the trigger snaps, after which bucket, water and cranked arm are weighed. The advantage of this method is that it avoids errors due to shaky hands: there is a personal element in dead-weight testing.

The National Rifle Association requires rifles used in competition to be tested with the barrel at an angle of 25° from the vertical, and revolvers and pistols with the barrel vertical. The latter is a considerable revision of a previous rule.

Adjusting Trigger Weight

Trigger weight is made up of two resistances to movement—the strength of the trigger spring and the force necessary to pull the sear off the bent. Some adjustment to trigger weight can be varied by adjustment of the spring, but this is not the correct method. The weight of the trigger is mainly due to the angle of

the face between the sear and the bent. If this angle is such that the sear tends to slide off the bent under the pressure of the main spring and in spite of the resistance of the trigger spring (see Fig. 63), the gun is positively dangerous, and may go off on the slightest jolt. If, on the other hand, the bent forms a hook which holds the sear in position, the trigger will be unduly heavy. The ideal trigger weight for any weapon falls between these limits and

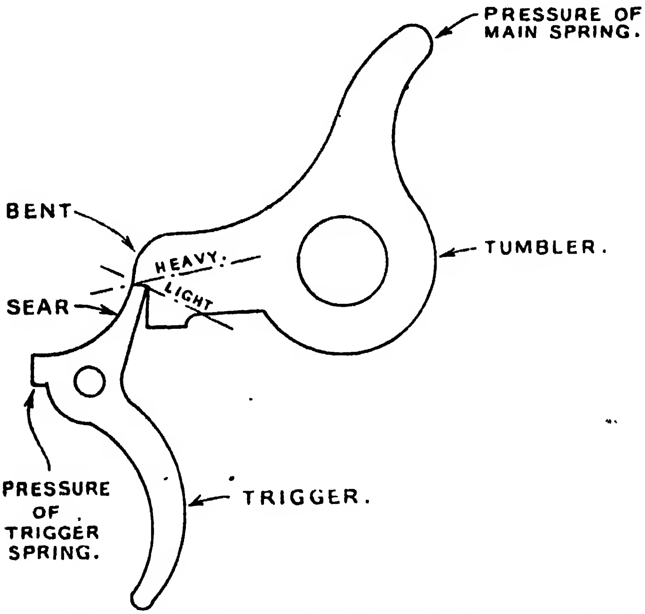


FIG. 63.—TRIGGER ADJUSTMENT FOR MARTINI ACTION.

is very critical, for a slight alteration of the angle of the face makes a marked change in trigger weight.

The method of trigger adjusting is to rub the surface with a fine stone slip: a triangular stone is a suitable one. This should be done carefully, the parts being held in the vice and the work being examined with a magnifying glass as it proceeds. If the alteration is properly done, the sear will bear over the whole surface of its end on the bent, not in patches only, as a touch of oil will show.

After a very little work has been done, the gun should be re-assembled and the trigger weight tested.

Other alterations to trigger pull, such as length of pull and alteration or removal of double pull, can be made to different types of action, and these need to be studied carefully; for the method applicable to one action may not serve, or may cause trouble if applied to another. Details are given in practical works on gunsmithing, such as *Advanced Gunsmithing* by W. F. Vickery, and *Modern Gunsmithing* by Clyde Baker.

CHAPTER XVI

SOME LEGAL ASPECTS OF SHOOTING

It is necessary to obtain a Firearm Certificate before one can hire, purchase, borrow or receive as a gift any firearm or ammunition other than a smooth-bore gun having a barrel of not less than 20 inches in length, an air-gun not of a dangerous type, cartridges containing five or more shot, none of which exceeds $\frac{9}{25}$ inch in diameter, or air-gun or blank ammunition, the last not exceeding 1 inch in diameter.

Application for a Firearm Certificate is made by attending in person at the *local* police station and filling in a form, on which must be stated the arm or arms it is desired to obtain and the amounts of ammunition desired to be purchased at any one time, to be held in possession at any one time, and to be purchased in all during a period of three years, and on payment in advance of a fee of five shillings.

The Chief Officer of Police will then grant a certificate, if he is satisfied that the applicant has good reason for acquiring the firearm and ammunition and can be permitted to have them in his possession without danger to the public safety. This certificate has to be renewed by fresh application every three years and payment of a renewal fee of half a crown.

A Firearm Certificate may be varied by similar application, in which case a fee of half a crown is charged only if the variation increases the number of firearms to which the certificate relates.

If no query is raised the certificate may be issued in a week or fortnight after the application has been made, but if the police are not satisfied that there is good reason for the firearm to be purchased, or that it will be used in a suitable locality, further investigations on their part may cause some delay.

Certificates are most easily obtained for *rifles of recognized target calibres* and for moderate quantities of ·22 ammunition, which are to be used for *practice and competition.* They are most difficult to obtain for pistols or revolvers, unless these are wanted for *practice and competition* and the applicant is a member of a recognized club. However, if a weapon is needed for sport or some purpose

other than target practice, the applicant should say so, otherwise he may find that he is restricted to using it at approved ranges only.

The way in which the police fill in Firearm Certificates may at first appear confusing. For example, when a variation is made on application for an additional rifle, this usually takes the form of:

> "I hereby vary this certificate so as to refer at 1 (ii) to one ·22 rifle."

But as 1 (ii) already read "one ·22 rifle" it would appear that no variation had been made, and for this reason the writer has on two occasions had the validity of a certificate variation queried by gunmakers. The police, however, consider that where a Firearm Certificate related to the purchase of one rifle, and that rifle was duly purchased and recorded on the certificate, a variation in the words given above permits the purchase of a second rifle.

The application form for rifles and ammunition and the appropriate pages of the Firearm Certificate require that not only the amounts and calibre of ammunition and the calibre of the rifle should be stated, but also the type. But whereas in the case of pistols the type of weapon or ammunition may have to be stated, the police are in fact interested in calibre only of rifles and in quantity and calibre of ammunition. When one applies for permission to purchase a Hornet rifle and ammunition to be used with it, the entry made on the certificate is no different from that for an ordinary ·22 rifle and ammunition.

The possession of arms and ammunition without a valid Firearm Certificate is a serious offence involving heavy penalties. For this reason, in order that there may be no misunderstanding or misinterpretation of the law, the relevant sections of the Firearms Act of 1937 are reproduced as follows:

> 1. (2) If any person—
>
> (*a*) purchases, acquires or has in his possession any firearm or ammunition to which this Part of this Act applies without holding a firearm certificate, in force at the time, or otherwise than as authorised by such a certificate, or, in the case of ammunition, in quantities in excess of those so authorised; or
>
> (*b*) fails to comply with any condition subject to which a firearm certificate is held by him;

he shall, subject to the provisions of this Act, for each offence be liable, on summary conviction, to imprisonment for a term not exceeding three months, or to a fine not exceeding fifty pounds, or to both such imprisonment and fine.

2. (5) The chief officer of police for the area in which the holder of a firearm certificate resides may at any time by notice in writing vary the conditions subject to which the certificate is held, except such of them as may be prescribed, and may by the notice require the holder to deliver up the certificate to him within twenty-one days from the date of the notice for the purpose of amending the conditions specified therein.

2. (7) A firearm certificate may be revoked by the chief officer of police for the area in which the holder resides if—

(*a*) the chief officer is satisfied that the holder is prohibited by this Act from possessing a firearm to which this Part of this Act applies, or is of intemperate habits or unsound mind, or is otherwise unfitted to be entrusted with such firearm: or

(*b*) the holder fails to comply with a notice under subsection (5) of this section requiring him to deliver up the certificate.

15. (1) Nothing in this Part of this Act shall relieve any person using or carrying a firearm from the obligation to take out a licence to use or carry a gun under the Gun Licence Act, 1870, or a licence to kill game under the law with respect to such a licence.

33. (6) The provisions of this Act relating to ammunition shall be in addition to and not in derogation of any enactment relating to the keeping and sale of explosives.

6. (1) Any constable may demand from any person, whom he believes to be in possession of a firearm or ammunition to which this Part of this Act applies, the production of his firearm certificate.

(2) If any person upon whom a demand is so made fails to produce the certificate, or to permit the constable to read the certificate, or to show that he is entitled by virtue of this Act to have the firearm or ammunition in his possession without holding a firearm certificate, the constable may seize and detain

the firearm or ammunition, and may require that person to declare to him immediately his name and address.

(3) If any person refuses so to declare his name and address, or fails to give his true name and address, he shall be liable on summary conviction to a fine not exceeding twenty pounds, and the constable may apprehend without warrant any person who refuses to so declare his name or address, or whom he suspects of giving false name or address, or of intending to abscond.

11. (1) No person shall sell or transfer to any other person in the United Kingdom, other than a registered firearms dealer, any firearm or ammunition to which this Part of this Act applies, unless that other person produces a firearm certificate authorising him to purchase or acquire it or shows that he is by virtue of this Act entitled to purchase or acquire it without holding such a certificate.

(2) Every person who sells, lets on hire, gives or lends a firearm or ammunition to which this Part of this Act applies to any other person in the United Kingdom, other than a registered firearms dealer, shall, unless that other person shows that he is by virtue of this Act entitled to purchase or acquire the firearm or ammunition without holding a firearm certificate, comply with any instructions contained in the certificate produced, and in the case of a firearm shall, within forty-eight hours from the transaction, send by registered post, notice of the transaction to the chief officer of police by whom the certificate was issued.

(4) If any person—

(*a*) contravenes or fails to comply with any of the provisions of this section; or

(*b*) with a view to purchasing or acquiring, or procuring the repair, test or proof of, a firearm or ammunition to which this Part of this Act applies, produces a false firearm certificate or a firearm certificate in which any false entry has been made, or personates a person to whom a firearm certificate has been granted, or makes any false statement;

he shall, for each offence, be liable on summary conviction to imprisonment for a term not exceeding three months, or to a

fine not exceeding twenty pounds, or to both such imprisonment and fine.

19. (1) No person under the age of seventeen years shall purchase or hire any firearm or ammunition, and no person shall sell or let on hire any firearm or ammunition to any other person whom he knows or has reasonable grounds for believing to be under the age of seventeen years.

(2) No person under the age of fourteen years shall accept as a gift or borrow any firearm or ammunition to which Part I of this Act applies, and no person shall give or lend any such firearm or ammunition to any other person whom he knows or has reasonable grounds for believing to be under the age of fourteen years.

(3) No person under the age of fourteen years shall have in his possession any firearm or ammunition to which Part I of this Act applies except in circumstances where he is entitled to have possession thereof without holding a firearm certificate by virtue of subsection (7), (8) or (9) of section four of this Act and no person shall part with the possession of any such firearm or ammunition to any other person whom he knows or has reasonable grounds for believing to be under the age of fourteen years, except in circumstances where that other person is entitled to have possession thereof as aforesaid.

(4) If any person contravenes any provision of this section he shall for each offence be liable on summary conviction to imprisonment for a term not exceeding three months, or to a fine not exceeding twenty pounds, or to both such imprisonment and fine.

16. (1) This Part (Part 1) of this Act applies to all firearms as defined in section thirty-two of this Act, except the following weapons and component parts thereof and accessories, thereto namely—

(*a*) a smooth bore gun having a barrel not less than twenty inches in length;

(*b*) an air gun, air rifle or air pistol not being of a type declared by rules made by a Secretary of State under this Act to be specially dangerous.

(2) This Part (Part 1) of this Act applies to all ammunition as

defined in section thirty-two of this Act, except the following articles, namely—

(*a*) cartridges containing five or more shot, none of which exceeds nine twenty-fifths of an inch in diameter;

(*b*) ammunition for an air gun or air rifle or air pistol;

(*c*) blank cartridges not exceeding one inch in diameter.

32. "Ammunition", except where otherwise expressly provided, means ammunition for any firearm as hereinafter defined, and includes grenades, bombs and other like missiles, whether capable of use with such a firearm or not, and prohibited ammunition;

"firearm", except where otherwise expressly provided, means any lethal barrelled weapon of any description from which any shot, bullet or other missile can be discharged and includes any prohibited weapon, whether it is such a lethal weapon as aforesaid or not, any component part of any such lethal or prohibited weapon, and any accessory to any such weapon designed or adapted to diminish the noise or flash caused by firing the weapon; *

"acquiring" means hiring, accepting as a gift and borrowing and the expressions "acquire" and "acquisition" shall be construed accordingly.

"transferring" includes letting on hire, giving, lending, and parting with possession, and the expressions "transfer", "transferee" and "transferor" shall be construed accordingly.

Further reference to the Act of is made in Chapter XXIII.

The Carrying of Arms

Anyone who has a valid Firearm Certificate and gun licence or game licence can carry firearms as specified in the certificate, or any gun for which a certificate is not required, at any time and in most public places. There is no need for the weapons to be carried under cover; also it is understood that there is no basis for the not uncommon belief that exemption from gun licence of rifle-club members is subject to the arms being carried under cover. (*See, however, postscript to this chapter.*)

There are, however, some restrictions. It is an offence to have

* Other accessories are not controlled by the Act. For example it has been ruled in Court that a Variation is not required for the purchase of a telescopic sight. —Author.

an offensive weapon at a public meeting or on the occasion of any public procession, otherwise than in pursuance of law and authority. It is an offence to discharge firearms in a cemetery (except as may be arranged at a military funeral). It is an offence to wantonly fire any gun or pistol within 50 feet of the centre of a highway. It is an offence to be found drunk when in possession of a loaded firearm.

PUBLIC ORDER ACT,

Section 4

"(1) Any person who, while present at any public meeting or on the occasion of any public procession, has with him any offensive weapon otherwise than in pursuance of lawful authority shall be guilty of an offence".

"(2) For the purposes of this section, a person shall not be deemed to be acting in pursuance of lawful authority unless he is acting in his capacity as a servant of the crown or of either Houses of Parliament or of any local authority or as a constable or as a member of a recognised corps or as a member of a fire brigade".

METROPOLITAN POLICE ACT, 1839

Section 54

"(15) Every person who shall wantonly discharge any firearm, or throw or discharge any stone or other missile, to the damage or danger of any person, or throw or set fire to any firework".

[In the Metropolitan Police District such a person is liable to a penalty.—Author.]

"And it shall be lawful for any constable belonging to the Metropolitan Police Force to take into custody, without warrant, any person who shall commit any such offence within view of any such constable".

Section 55

"No person other than persons acting in obedience to lawful authority shall discharge any cannon or other firearm of greater calibre than a common fowling piece within 300 yards

of any dwelling house within the said district to the annoyance of any inhabitant thereof. . . ."

HIGHWAYS ACT, 1835

Section **72**

"If any person . . . shall wantonly fire off any gun or pistol. . . within fifty feet of the centre of such carriageway or cartway . . . every person so offending in any of the cases aforesaid shall for each and every such offence forfeit and pay any sum not exceeding forty shillings over and above the damages occasioned thereby"

LICENSING ACT, 1872

Section **12**

"Every person who . . . is drunk when in possession of any loaded firearms may be apprehended, and shall be liable to a penalty not exceeding forty shillings, or in the discretion of the court to imprisonment with or without hard labour for any term not exceeding one month"

POST OFFICE ACT, 1908

Section **63**, (1)

"A person shall not send or attempt to send *or procure to be sent* a postal packet which either——

(*a*) incloses any explosive substance, . . ."

There are also restrictions on the carrying of firearms, explosives, etc., on public vehicles. But these are not very onerous to the rifleman or sportsman because they amount merely to forbidding the carrying of *loaded* firearms or quantities of dangerous substances.

As far as the Railway Executive is concerned, the Byelaw relating to the conveyance of firearms, etc., reads as follows:

"No person shall take into, or place in or upon or cause to be taken into or placed in or upon, the railway or any carriage or vehicle upon the railway, any loaded firearm, loaded gun, or loaded weapon of any kind, nor shall any person, except by permission in writing of an officer of the Company duly authorised in that behalf, take into or place in or upon, or cause to be taken into or placed in or upon the Railway or any

such carriage or vehicle, any inflammable explosive or corrosive gas, spirit, liquid, substance or matter, or any article or thing which is or may become dangerous to any passenger or property. But nothing in this byelaw shall apply to small quantities of spirit or liquid carried for the personal use of such person, and not for the purpose of trade or business, provided that all due precautions are taken for the prevention of accident or injury therefrom. If any person offending against this byelaw fails to remove from the railway or any such carriage or vehicle immediately upon request by any servant or agent of the Company, any article or thing to which this byelaw relates, the same may be removed therefrom by or under the direction of such servant or agent without prejudice to any penalty incurred by the infraction of this byelaw."

On the railways of the London Transport Executive, which include all the sub-service lines in London other than the Waterloo and City Railway, the matter is covered by Byelaw No. 18 of the L.P.T.B. Railway Byelaws and Regulations. This Byelaw provides as follows :

"No person shall take into, or place in or upon, or cause to be taken into or placed in or upon, any lift or vehicle, or elsewhere upon the Railway any loaded weapon of any kind, or any cinematograph film or any inflammable, explosive, or corrosive gas, spirit, liquid, substance or matter, or any article or thing which is or may become dangerous to any passenger or property."

The carriage of firearms and ammunition on public service vehicles (*i.e.* all forms of passenger road transport vehicles other than trams and trolley-buses) is governed by the Public Service Vehicles (Conduct of Drivers, Conductors and Passengers) Regulations 1916, Regulation 10 of which provides that a passenger or intending passenger shall not "enter or travel in or on a vehicle with loaded firearms or any dangerous or offensive article". These Regulations are made under the Road Traffic Act, which lays down certain penalties for any breach thereof.

With regard to the carriage of firearms and ammunition on the London Transport Executive's trams and trolley-buses, an identi-

cal provision to that quoted above is contained in the Tramway and Trolley-bus Byelaws by Byelaw No. 2 (XIX). These Byelaws are made under Section 46 of the Tramways Act 1870, and Section 61 of the London Passenger Transport Act 1938, and penalties are provided in the Byelaws in respect of any contravention thereof.

Export and Import Licences

Sportsmen leaving the country can take one or two smooth-bore guns with them as passenger's baggage without an export licence, and also rifled arms and ammunition, provided that they hold a valid British Firearm Certificate. But an export licence is necessary for all export by gunmakers.

The import of weapons coming under the Firearms Act is also subject to restrictions, and perhaps the simplest way to arrange for import is to ask a gunmaker to deal with it.

Gun Licences

Apart from exceptions which are given below, before anyone can carry or use any rifle, pistol, gun or air gun other than in the curtilage of a house, either a gun licence or a game licence is required. These can be obtained at a post office. The former costs ten shillings, and is available until the 31st July following the date of purchase. It permits one to carry a gun but not to take game.

Possession of a Firearm Certificate does not exempt from holding a licence, but a member of the National Rifle Association, the National Small-bore Rifle Association, or of any approved rifle club holding a gun licence exemption certificate can carry a rifle or pistol for the *purpose of practice and competition* without a licence.

A game licence must be held not only for the purpose of shooting game, but also for taking game by netting or snaring. The following are the charges for game licences :

One year, expiring 31st July	£3
Gamekeeper's Licence for whole or part of a year expiring 31st July	£2
Three months, expiring 31st October . . .	£2
Nine months, expiring 31st July . . .	£2
Any continuous period of fourteen days . .	£1

A game licence entitles the holder to sell game to a licensed dealer.

The Right to Shoot Game

The owner of land has the right to shoot game on his land and, provided he is the occupier also, he may continue to shoot ground game on his land even if he has granted the rights to another.

The occupier of land has the right to kill ground game, and he may authorise in writing one other person who is a resident on the land or employed thereon to kill ground game with firearms.

Close Seasons

The open and close season for game birds are covered by various Acts commonly referred to as "The Game Laws". The seasons for duck and geese are governed by the Wild Birds (Duck and Geese) Protection Act. The protection of wild birds generally (including quail, snipe and woodcock, and birds other than duck and geese that are often loosely referred to as wildfowl) is covered by various Acts, notably the Wild Birds Protection Act, 1880, under which special Orders may be made locally. Such Orders are published in *The London Gazette*, but inquiries should be made at local police stations as to what birds are protected, and between what dates, in each county or area.

The shooting of game is illegal in England on Sundays and Christmas Day. "Wild birds" may be shot in season on Sundays in England except in those counties where Sunday shooting is prohibited by County Order. "Wild birds" include woodcock and snipe, and—in this instance—wild geese and wild duck.

Game-shooting Seasons. (England, Scotland and Wales only)

All dates inclusive.

Grouse	12th August–10th December
Blackgame *	20th August–10th December
Ptarmigan	12th August–10th December
Partridge	1st September–1st February
Pheasant	1st October–1st February
Duck and Geese	12th August–31st January
Hare	No close season, but hares may not be sold or offered for sale during the months March to July, and must not be shot on Sundays or on Christmas day.

* In Somerset, Devon and New Forest the shooting dates for Blackgame are 1st September to 10th December.

Residents in Northern Ireland and Eire should refer to local sources for dates of game seasons.

Trespass

To trespass on someone's land is not a serious matter unless damage is caused, but anyone caught trespassing is advised to at once offer a halfpenny with respect to any damage that may have been caused in walking over the land. On the other hand, a trespasser in pursuit of game can be fined, and five or more persons trespassing together can be fined for trespassing with the intent of poaching. Poaching at night is a more serious offence, for which terms of imprisonment can be given. Night poaching includes unlawfully taking game or rabbits on a public road.

It is usually understood between landowners that if a man shoots game on his own land and it falls on the land of another, he may cross the boundary to retrieve his quarry, leaving his gun behind him; but this is not a legal right.

In many places it is permissible for anyone to shoot on the foreshore—*i.e.* below the line of average high tide. But this cannot be presumed, for in probably the majority of instances the foreshore has been granted to the lord of the manor or some other person.

Postscript.—While this book is at press, the *Prevention of Crime Bill* is still before Parliament. In spite of assurances by its promoters that the innocent citizen and *bona fide* rifleman will have nothing to fear when the Bill becomes law, there is reason for more than one opinion on the point. The reader is advised to obtain a copy of the Act on publication.

CHAPTER XVII

ACCIDENTS, BURSTS, ETC.

FIREARMS are very dangerous if improperly handled; and while accidents with firearms may not happen every day, when they occur they can lead to fatalities or serious injuries. Firearm accidents most frequently are caused by careless handling and lack of proper precautions and, as may be expected, they are less common than elsewhere at rifle clubs and competitions where rules enforce safe practices.

Another aspect of the safe use of firearms is courtesy. It is part of the etiquette of all branches of shooting to handle the rifle or gun in such a manner that not only is no danger involved, but also no anxiety or discomfort is caused to others present. In the shooting-field a sportsman may lose his nerve, and his bag be reduced accordingly, if his neighbour breaks the rules of safe shooting. At the rifle club, where very little difference of form makes or mars the score, many a card can be ruined because someone does not sufficiently consider his fellows. In all fields of shooting the company of the safe shot is much preferred to that of the man who makes a big bag or high score but does not care how he does it.

AT THE RIFLE CLUB

On arrival at the club, the member should take his rifle out of its case and, pointing it in a safe direction, immediately open the breech. The breech should be kept open *all the time* the rifle is at the club except when the rifle is being used at the firing-point or when the breech must be closed for some legitimate reason, such as trigger-testing. Whenever a shooter comes off the firing-point, he should do so with the breech of his rifle open, and all rifles in the racks should have their breeches open.

Rifles should always be handled at the club as if they were loaded and not pointed at anyone accidentally, and certainly not by intention. The correct way of handling a rifle in the club-room is to hold it in both hands and at all times be conscious of the direction in which the muzzle is pointing. The muzzle should be

pointing either upwards or downwards, and the barrel swung so as never to point at a club member. Aiming and trigger snapping should not be permitted in the club-room.

No member should pick up anyone else's rifle except by permission, and should never pick up a rifle without opening the breech, should it be closed.

When on the firing-point, the rifle must be brought to the shoulder only after targets have been changed and the range officer has given the recognized signal to start firing. And in bringing the rifle to the shoulder it should not be swung in an awkward manner in the direction of the next shooter: each man should learn how to put on his sling holding the rifle with the muzzle towards the target.

When targets are being changed, all rifles must be lying on the ground, unloaded and with their breeches open, and on no account should they be sighted in the direction of the targets or held to the shoulder.

On leaving the club, the shooter should look into the chamber of his rifle to make sure that it is empty, then close the breech and snap the trigger before placing the rifle in its case.

The National Rifle Association's recommended rules for rifle or pistol clubs include the following:

1. Only rifles and/or pistols and ammunition suitable to the range shall be used.

2. The Committee shall appoint a Shooting Superintendent, who shall always be present during practice, and be in sole authority and responsible for the observation of all rules for the conduct of the shooting.

3. No one but the Shooting Superintendent, or person authorised by him, shall be allowed to go in front of the firing-point whilst practice is being carried on.

4. Any member pointing a rifle or pistol, loaded or unloaded, at any person under any circumstances, or being guilty of any practice which in the opinion of the Committee is dangerous, will be liable to expulsion from the club.

5. No person may load until he has taken up his position on the firing-point, and no person may leave the firing-point without first having unloaded his rifle or pistol.

6. At the word "Cease Fire" all rifles and pistols must be unloaded, and remain so until "All Clear" is given.

7. Club rifles, pistols and ammunition must be stored in a place provided by the club for that purpose.

At Open Meetings

At the Bisley meeting of the N.R.A. no rifle may be loaded or fired until after the red (shooting) drum has been hoisted on the Clock Tower Hill, and no fresh competitor may commence to fire after the drum has been lowered to half-mast. No competitor may load until he has taken up his position at the firing-point. Whilst adjusting sights or uncharging magazines, or whilst loading or unloading, all competitors must hold the muzzles of their rifles towards the target. The rifle and magazine of every competitor must be examined by the range officer (or register-keeper acting under his orders) immediately after firing at every distance in the competition. A competitor who fails to present his rifle for inspection as required by this regulation, whether called on to do so or not, may be considered as acting in a way that might prove dangerous, and dealt with accordingly.

Any competitor who loads his weapon or fires before the second blast has been sounded and the red (shooting) drum hoisted, or discharges a firearm within the enclosure except in accordance with the regulations for shooting, or is found with a loaded firearm except at the firing-point and within the hours of shooting, or discharges a firearm accidentally or acts in any way that might prove dangerous, is liable to forfeit every prize won by him since the occurrence, be excluded from all further competition at the meeting and forfeit all his entrance fees.

Pistols and Revolvers

Pistols and revolvers are more dangerous than other arms because, being short in overall length, they are very easily pointed in dangerous directions. The length of a rifle or shotgun makes the weapon easy to handle with the muzzle pointing upwards or to the ground. On the other hand, a pistol taken from a drawer, from the table or from its holster naturally assumes a horizontal position.

For pistol clubs the N.R.A. recommends:

1. All shooting will take place behind a table of not less than 2 feet 6 inches in height. Such tables may be portable.

2. No firing at moving targets is permitted.

3. Whilst loading, the weapon must be held over the table, muzzle pointing to the ground towards the target. Loading is not allowed until the competitor is in position for firing, and the target has been run or taken out to the butt.

4. Should there be from any cause an interruption in the shooting, the competitor must at once open his revolver or unload his pistol and lay it on the table, muzzle towards the target, and will complete his shooting as soon as the target is clear.

5. Immediately after firing, and before quitting the table, every competitor must open his revolver or pistol and extract all cartridge cases; after this is done, and not until then, the target will be brought to the firing-point.

6. Rifle and pistol shooting must not be carried out simultaneously on the same range.

7. Not more targets should be set up than can be conveniently shot at and supervised.

The N.S.R.A. rules for pistol shooting require that no arm shall be loaded until the competitor has taken his place at the firing-point and the range officer has given command to load. Whilst it is being loaded, the weapon must be held over the table with the muzzle pointing to the ground towards the target, and after it is loaded it must be held touching the table until the order to commence firing is given. When the command "Cease fire" is given each competitor must stop firing and open the action of his weapon. When not on the firing-point competitors must, at all times, carry their guns unloaded with cylinders open or slides back and magazines out unless holstered. (Here it should be mentioned that removing the magazine from a self-loading pistol does not ensure safety—there may be a cartridge in the chamber).

In the Shooting Field

Shooting is not allowed between drives during an organized shoot, and at such times no gun should be carried loaded. Neither should guns be carried loaded at any other time when shooting is not in progress—*e.g.* when picking up game.

To make sure that a gun is not loaded, and for the courtesy of letting his companions know that he is carrying an empty gun,

it is best for the sportsman to carry it over the arm with the breech open. When a gun is carried on the shoulder, it should be held with the triggers up, as this erects the barrel, as well as reducing the risk of the gun being accidentally fired. When going through a stile or over a gate it is not sufficient to put the gun on safe: it should be unloaded. And afterwards it should be closed, not by lifting the barrel, but by lifting the butt, so that when the breech is closed, the muzzle is pointing towards the ground.

When walking up game, the shooter should hold his gun with the muzzle pointing down. He should keep in line, not going ahead or falling behind his neighbours, and should never let his gun point down the line, and he should not turn round to look back. If a bird should cross the line it should be allowed to pass, and the muzzle of the gun be brought over vertically, not following the bird round. When approaching a neighbouring gun, a sportsman should open his action. Guns should always be unloaded at the end of a drive and never left about loaded.

A shot should never be taken at concealed game, such as a rabbit in a hedge, or any animal that cannot be seen distinctly, for it might not be game!

Clay Bird Shooting

At clay bird shooting no loaded guns are allowed on the field except in the hands of the shooters when in position to shoot. No shooter is allowed to load his gun until actually at the firing-mark, and he must not turn away from the firing-mark without opening his gun and removing the cartridge.

The Sporting Rifle

Unlike shotgun pellets, the extreme range of which is little more than 200 yards, and which are not dangerous at that distance, rifle bullets travel for long distances, and are dangerous at their maximum range: even the small ·22 Long Rifle cartridge has a range of about three-quarters of a mile, and is dangerous at that distance.

In a populous country like Great Britain, rifle-shots must therefore be taken with considerable precautions. In most cases a sporting shot cannot be taken safely except where there is a bank or other natural bullet-stop behind the target. Also a bullet which misses or penetrates the target may ricochet from the ground

and go a very long way. This is particularly so in stony places. Bullets have been known to go into the ground and come out again.

Bullets ricochet from water at unpredictable angles. This makes it unsafe to shoot over water, except where it is known that no one is within ultimate range.

Danger from ricochets is greatly reduced if soft-point bullets are fired from high-velocity cartridges such as the "Varmint" loads used in America for shooting woodchucks, coyotes, etc.; or the ·22 Hornet cartridge in this country. A soft-point, high

FIG. 64.—THE ·22 RIFLE CAN BE FIRED WITH SAFETY IN VERY OUT-OF-THE-WAY PLACES.

velocity bullet breaks up on hitting the ground and the small pieces do not go very far.

ACCIDENTS DUE TO LEAVING WEAPONS LOADED

Time and time again accidents have occurred with firearms that were believed to have been unloaded. Mistakes can be made; and a weapon put down unloaded by one man may be loaded by another. Or again, the chamber of a repeating weapon may be empty, and yet a cartridge be brought out of the magazine into the chamber by someone operating the action. It is for these reasons that no pistol, gun or rifle should be left lying about with a cartridge in the chamber or magazine, or left where anyone not experienced in the use of weapons and disciplined to habits of

safety might get hold of it. A loaded gun should never be taken into a house or building. Neither should a loaded firearm be put away in gun-cupboard, drawer or elsewhere.

One would think it hardly necessary to mention that children should not be allowed to have access to arms and ammunition until they are old enough to use them, were it not that fatal accidents have been caused by children handling firearms believed to be unloaded. It cannot be too strongly stressed that, in families where firearms are familiar objects, young children should be taught to treat all weapons, including toys, with respect. Misdemeanours in this connection should be dealt with more severely than would be necessary in other families, because otherwise familiarity would eventually amount to contempt and tend to change the possibility of accidents to probability.

Personal Safety

A new rifle received from the makers usually has the barrel sealed with Vaseline or other grease to protect it from rust. Or it may be heavily greased internally from end to end. This grease must be removed before the rifle is fired, or the barrel will split, or, in the case of a little grease, be enlarged and rendered inaccurate.

When using a Martini rifle with rim-fire ammunition, care should be taken that the cartridge is right in the chamber before the breech is closed, for it is not impossible to fire the cartridge by crushing the rim on closing the breech. The cartridge should be pushed into the chamber with the forefinger until it does not project. The shooter should develop the habit of closing the breech lightly, so as to know at once if there is any resistance such as might be caused by a cartridge that had not gone right in.

If a cartridge will not go into the chamber, it should be extracted carefully, not flicked out and lost in the dark for someone to tread on, or to be swept up and put in the bin for fired cartridges to the danger of the men who melt down the old cases.

If a revolver must be carried on the person, it should be loaded in five only of the six chambers, the hammer down on the empty chamber. Several accidents have occurred through neglect of this simple precaution.

Shotguns are easily burst by stoppages. If a cartridge should misfire, the primer only blowing the contents into the barrel, the

shooter should not put in a second cartridge without making sure that the barrel is clear of wads, etc., as this might cause a burst. The shooter should look through his barrel frequently to make sure that it is clear. Earth, snow or vegetation getting into the muzzle of a gun can also cause a burst barrel.

There is a serious danger from getting cartridges mixed. A 20-bore cartridge if placed in the chamber of a 12-bore gun will slide into the barrel, making the gun appear empty. If a 12-bore cartridge is then put in the chamber and fired, the gun will burst. Similarly, 28-bore cartridges can be inserted in the barrel of a 16-bore gun.

A shotgun cartridge longer than that for which the gun is chambered should not be used, for it is almost certain to contain a charge larger than that for which the gun was intended.

Rifle cartridges should not be fired if they show splits on the shoulder or body, creases or folds in the neck or shoulder, deep longitudinal scratches, very deep dents or advanced corrosion. Pistol cartridges should not be used if the bullet is seated deeper than normal.

It is dangerous to convert "solid" jacketed bullets to expanding bullets by filing off the nose. This has been done without accident in the case of military cartridges which have thick jackets, but there is always the possibility of the lead core of the bullet being blown through the hole made in the nose, leaving the jacket in the barrel to serve as a stoppage.

Blank Cartridges

Blank ammunition can be dangerous. In spite of the fact that it is issued for use at field days to cadets, and even schoolboys, it should be used with caution, Blank cartridges should never be fired at people, because there is always a possibility of the crimped end of the cartridge being blown out of the barrel, and at short range the powder residue is dangerous. Walter Winans relates that he once saw a man's eyes permanently injured by burnt powder in a mock duel on the stage.

Mention has already been made of the fact that blank cartridges contain rapidly burning powder which is liable to detonate if pressure is developed. They should therefore never be used with shot, ball or any improvised projectile, as to do this would most probably cause a burst.

Cartridges Exploded when Not in a Gun

Arthur Hearn in *Shooting and Gun-fitting* describes how, to answer the query what would happen were a shotgun cartridge exploded in the pocket, he fired two cartridges by placing them on the ground and shooting at them with a 12-bore. The powder simply burned out through holes made in the case by the shot which struck the cartridges, while the charge of shot and wads remained intact in the cases. On the basis of this and further similar experiments he arrived at the conclusion that a shotgun cartridge is safe outside the barrels of a gun.

The experiment is not, however, convincing because the method of firing a cartridge by shooting at it with spread shot entails the piercing of the case before the explosion has taken place, thereby preventing pressure from developing sufficiently to ensure proper combustion of the powder. It would have been more convincing if the primer had been exploded with a single air-gun pellet.

The writer tried the experiment of cooking a ·22 Long Rifle cartridge (Kleanbore with brass case) by standing it on its base in a tin over a gas flame. The cartridge exploded with a comparatively loud report, bulging the whole surface of the bottom of the tin ($2\frac{5}{8}$ inches diameter), perforating it in one place and leaving a marked impression of the cartridge base. There were also dents caused by flying fragments and the mark of the bullet on the concrete ceiling.

After careful search the only fragments of the cartridge found were the base, small pieces of brass and the bullet. The base of the bullet was expanded to 0·25 inch diameter by gas pressure, and there was a dent where it had struck the ceiling.

The experiment was repeated with a Winchester Super Speed cartridge with cupro-nickel case and hollow-point copper-plated bullet. The effects were almost identical. The bullet was not expanded by gas pressure, but flattened down one side where it had struck the ceiling to an extent which suggested an energy of only a fraction of a foot-pound.

These experiments also are of limited value because, in firing a cartridge by cooking it, heating the powder prior to the explosion is unavoidable, and therefore the explosion may be abnormally violent. They do suggest, however, that more than

minor injury would be unlikely to be caused to anyone near to the explosion, provided that they were wearing glasses and not practically in contact with the cartridge.

Major-General Julian S. Hatcher in *Hatcher's Notebook* describes some experiences of the explosion of cartridges heated in jammed machine-guns. In one instance the cartridge fired immediately after extraction from the breech of a hot Browning automatic rifle. He states that usually such explosions are just sufficient to tear open the cartridge-case and impart a very low velocity to the bullet.

Barrel-bursts and Action Failures

Failures may be classed as:

1. Barrel-bursts or action failures caused by excessive pressure.
2. Barrel-bursts or bulges due to obstruction.
3. Barrel-bursts or action failures due to flaws or weakness of the metal.
4. Failures due to combinations of the above causes.

Any burst of the barrel which does not occur near to the chamber is very unlikely to be due to excessive pressure because gas pressure falls off much more rapidly than the thickness of the metal is reduced towards the muzzle. Excessive pressure due, for example, to an overcharge of powder has not been known to burst a shotgun barrel at a point more than 1 inch in front of the chamber.

Such excessive pressure either bursts the chamber or wrecks the action. In the latter case the barrels of a shotgun are lifted off the face, the bar breaking near the angle it makes with the standing breech; or the action body of a rifle is ruptured. Damage may also be caused by gases escaping into the action on the failure of the cartridge head. Revolvers usually fail by bursting of the cylinder wall.

If the cartridge has not failed, excessive pressure is shown by expansion of the head of a rifle cartridge, impression of the extractor mark on the metal portion of a shotgun cartridge, and flattening of the percussion cap in both cases or, under extreme pressure, blowing out of the cap. Accidents due to failure of the cartridge may happen without excessive pressure if a gun is "off the face" or a rifle has excessive headspace.

Although a 20-bore cartridge placed ahead of a 12-bore cartridge might be considered an obstruction, the damage resulting therefrom would be due to excessive pressure.

Obstructions in the barrel of a rifle or gun not immediately in contact with the cartridge always cause one or more rings or bulges visible internally or externally if they are sufficient to cause any damage at all. Evidence of this ring formation is normally present whether or not the barrel bursts. A ring formed on a shotgun is a short swelling of the barrel slightly nearer the muzzle than the point where the obstruction was located. The ringing of a rifle-barrel is more easily seen from the inside unless it is very marked.

There is not complete agreement on the reason why obstructions cause ring-bulges. One view is that the sudden stoppage of the bullet or the charge of shot sets up the lead, expanding it in the bore, pushing the sides of the barrel outwards. Another is that a wave of gas pressure builds up behind the retarded shot and causes the ring. Experiments quoted show that both opinions are probably true, according to circumstances.

Bursts not at the chamber and not causing a ring, or, in the case of a rifle, not due to grease in the barrel, can be attributed to weakness of the material. Weakness of barrel or of action body has often been traced to one of the following: undetected flaws such as inclusion of slag or bubbles in the metal, and weakening of the structure of the metal by overheating.

If a particle of slag or an air bubble is formed in the steel during manufacture, the process of rolling or forging extends this to a lamination. While every care is taken to detect such flaws in manufacture and in viewing at the Proof House, occasionally one will remain undetected, and may eventually become the cause of failure.

Several military rifle actions in America failed from overheating during manufacture.

Shotgun barrels can be weakened considerably by rusting, a very vulnerable point being the junction between barrel and rib or the space beneath the rib if moisture can enter.

What is remarkable about failures of both rifles and shotguns is the comparatively small number of serious injuries to the shooter that they have caused.

CHAPTER XVIII

THE NATIONAL RIFLE ASSOCIATIONS

British target-shooting is organised by the National Rifle Association (N.R.A.), which is concerned with target-shooting with all types of rifles and pistols, in particular those of military calibre, and the National Small-bore Rifle Association (N.S.R.A.), which is the governing body of the numerous small-bore clubs who shoot with the ·22 target rifle and pistol.

The National Rifle Association (whose address is Bisley Camp, Brookwood, Woking, Surrey) was founded in 1860 and incorporated by Royal Charter in 1890. Its objects are " To promote and encourage Marksmanship throughout the King's Dominions in the interests of Defence and the Permanence of the Volunteer and Auxiliary Forces, Naval, Military and Air ".

The Association was formed in close association with the Volunteer movement; for at that time apprehension of a French invasion had led to the formation of numerous volunteer corps and rifle clubs, the proper organisation of which brought to birth the Volunteer force.

It was originally intended that, to promote popular enthusiasm, a rifle-shooting " Derby " should be held annually in different parts of Great Britain; but this was found to be impracticable, and for many years the annual meeting of the N.R.A. was held on Wimbledon Common, where it became one of London's social events. However, the increased range of improved ammunition, together with complaints from Wimbledon residents, eventually made it necessary for a new range to be found, and after some considerable difficulty and delay the N.R.A. finally moved to Bisley Camp, where headquarters were established, and henceforth the annual meeting was regularly held there.

Apart from this Bisley meeting, held in July, and an autumn week-end gathering for pre-service cadets, the N.R.A. does not organize any rifle meetings. But affiliated county rifle associations organize their own meetings throughout the country during the season April to September, and many affiliated clubs, especially

those using the Bisley ranges, conduct meetings for their members; also large meetings are held by H.M. Services.

Membership and Affiliation

The N.R.A. is supported by individual members and affiliated clubs. Individual membership is essential to competition at the N.R.A. Bisley meeting; it is not sufficient for a competitor to be a member of an affiliated club. Affiliation is, however, essential to clubs other than small-bore clubs, who need to be affiliated only to the N.S.R.A., but many of which nevertheless are affiliated to the N.R.A. also.

Affiliation to the N.R.A. entitles clubs to obtain War Department pattern ammunition at cost price, on application to the C.O.O. of the Area in which the club is situated, and entitles their members to exemption from payment of gun licence in respect of private rifles used for musketry practice. A certificate of exemption from Gun Licence Duty is issued to each club by the N.R.A. when the Home Office have approved the club which covers all rifles and members of the club on certain stated ranges approved by the military authorities and Home Office. Home Office approval is always applied for by the N.R.A. on behalf of each club as its affiliation is completed, the club being informed when a reply is received from the Home Office. There is therefore no action that the club need take in this connection other than to give the police, on request, full information about all ranges the club intends to use.

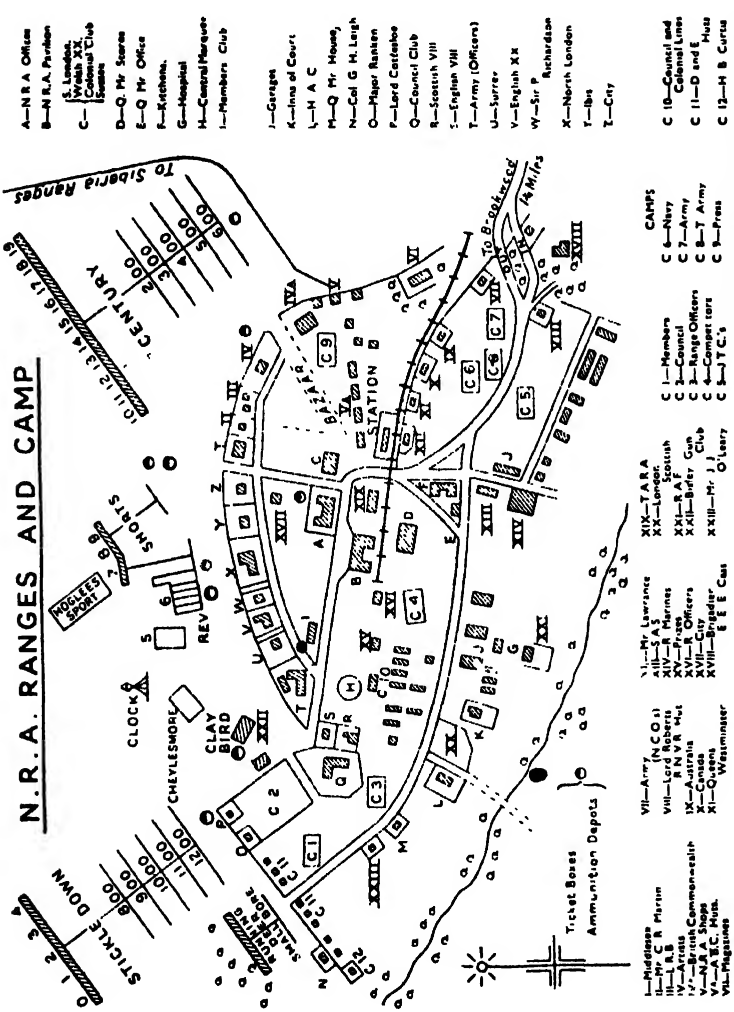
The National Rifle Association publishes as its official journal the *N.R.A. Journal and Shooting News*, which is obtainable from Gale & Polden Ltd., The Wellington Press, Aldershot, Hants.

The Bisley Meeting

During the annual prize meeting, the N.R.A. has a camp for members only, a camp for competitors, and a limited number of furnished huts which may be hired. Also members are permitted on payment to park their own caravans in the special area allocated during the Bisley meeting, the N.S.R.A. meeting, and at other times.

Bisley Camp is a good mile from Bisley station. For many years a special train, affectionately known as the " Bisley Bullet " ran on a single line from Brookwood to the terminus at Bisley

during the three weeks of the N.R.A. and N.S.R.A. meetings. In 1952 it made its last journey by order of the British Railways Executive. A mock funeral service was held at Bisley and the



[By courtesy of The National Rifle Association.

FIG. 65.—MAP OF BISLEY CAMP.

train, crowded to overflowing, was driven over lines dotted with detonators to Brookwood where, near the famous cemetery, it was received by Scottish pipers playing a dirge. It is understood that in future motor coaches will be provided.

Arriving at Bisley, the visitor finds, just outside the station, the N.R.A. offices and pavilion, with restaurant and bar, and lying to the north-east the bazaar lines where the gunsmiths have their booths. Farther to the north is the crescent of civil and military clubhouses.

The " Century " rifle range, so called because it has a hundred targets side by side, lies to the north-east. It is here that the 200- to 600-yard range competitions are shot. The Stickledown range, to the north-west, is arranged for shooting at 800 to 1,200 yards, and has fifty targets. Farther away to the north is the

FIG. 66.—BISLEY.
On the left is the Pavilion, and on the right the N.R.A. Offices.

Siberia range, not used at present during the meeting. The running deer range, used for small-bore shooting also, lies to the west of the camp, just beyond the sleeping-huts.

The general impression of Bisley is very pleasant in good weather, for the various buildings, while not of any architectural merit, are well spaced out among the fields, ranges, avenues of trees and woods. Views of hilly and wooded country extend even beyond the longest range.

At the Bisley meeting many competitions are held for deliberate shooting with the service rifle " a ", service rifle " b ", sniping rifle, match rifle, free rifle and sporting rifle. There are also revolver and pistol competitions in military and ·22 calibre,

FIG. 67.—THE BAZAAR LINES, BISLEY.

FIG. 68.—ON THE CENTURY RANGE, BISLEY.

shooting with the two-twenty bore rifle at 200 yards range, and shooting at moving targets such as the "running deer", the "rabbit" (which makes five appearances each of five seconds duration at irregular intervals) and the "advancing man" (revolver). There are prizes for clay pigeon shooting, for which entries can be made on the ground.

The Queen's Prize

Her Majesty the Queen's Prize, for many years known as the King's Prize, in reassumed its original title. This is the main event of the Bisley fortnight, and the one which culminates in the most impressive scene. The competition, open to all subjects of Her Majesty the Queen, is an Empire competition, competed for with the service rifle "b", and shot in three stages. The first stage is shot at 200, 500 and 600 yards; the second, which is open to three hundred qualifying competitors only, at 300, 500 and 600 yards; and the third stage, in which the "Queen's Hundred" shoot, at the distances of 900 and 1000 yards. The third stage is the last event of the Bisley fortnight, and is followed by the traditional chairing of the winner round the camp in the ceremonial carrying-chair, preceded by a band playing "See the Conquering Hero Comes", which tune has been used on this occasion ever since Queen Victoria first presented the prize in 1860.

The National Small-bore Rifle Association

The National Small-bore Rifle Association has as its primary interest shooting with rifles of ·22 calibre at ranges of 15, 20, 25, 50 and 100 yards, mainly in the prone position. The longer-distance shooting (50 and 100 yards) is out of doors in the summer months, but shooting at ranges up to 25 yards is in the main carried on throughout the year at indoor ranges.

Like the N.R.A., the N.S.R.A. is an association of clubs to which it offers similar advantages, including initial advice on club formation, the arrangement of free inspection of ranges by the military authorities, issue of a certificate giving exemption from payment of Gun Licence Duty, and securing approval of the Home Office. The association publishes *The Rifleman*, circulation about 6,500 copies, and affiliated clubs receive a free copy of this.

The N.S.R.A. is a much younger association than the N.R.A., for it was formed by Field-Marshal Lord Roberts in 1901 as "The Society of Miniature Rifle Clubs". But owing to the great popularity of small-bore shooting and the ease with which a small-bore range can be constructed, there are, at the time of writing, very nearly 3,700 affiliated clubs.

As opposed to many other sports in which matches are held at home or away, teams visiting one another on pre-arranged dates, a very large part of small-bore rifle competition is so organised that competition and team match cards may be shot by club members at their own range and at any time between two specified dates, or on one day within such period as may be laid down. The cards so fired are witnessed by officers of the clubs concerned and are signed by them and the competitors. After the conclusion of the shoot the cards are, within twenty-four hours, posted to the N.S.R.A. for the shots to be valued.

This is one of the important duties of the Association, which, together with its other services to the affiliated clubs, involves expenses exceeding the income derived from the low affiliation fees. The association, in fact, depends very largely upon profits on sales (at discount prices) of ammunition and equipment.

Competitive shooting of the clubs affiliated to the N.S.R.A. includes club matches between individuals, and matches between teams and clubs. For the purposes of inter-club competition, local associations or leagues and county associations are formed of not fewer than six rifle clubs. Open meetings of the Association are also held, annually in Scotland and at Bisley, whilst international matches, including the Dewar between Great Britain, the United States and the Dominions, are fired under the "postal" system. The Pershing Match is shot at Bisley on the infrequent visits to Britain of a U.S.A. team. During the summer months some forty or fifty open-air prize meetings are arranged for the country and local Associations.

The address of the National Small-bore Rifle Association is 113, Southwark Street, London, S.E.1.

Rules for Competition Shooting

The competitions that may be shot and the rules of competition vary from year to year. English service-rifle shooting is largely based on the tradition of the use of the service rifle, and is

regulated in accordance with service conditions of shooting, but in the main this, and more particularly small-bore shooting, is carried out on very similar lines to shooting in America. Several of the rules applicable in this country agree word for word with those of the United States N.R.A., and differences are, in fact, minor.

Rifles Used in Competition Shooting

As mentioned in Chapter X, three patterns of service rifle may be used in the Bisley competitions, but the ways in which these may be altered and adjusted depend on the class of competition, for some competitions are for the rifle as issued to the services; while others permit adjustments and improvement of sights so as to derive from the rifle the best shooting of which it is capable, and also to provide a means by which the qualities of standard and new types of ammunition may be tested by expert riflemen.

Service Rifle Class A includes the British service rifle Nos. 1, 3 and 4 as manufactured for the Government, or a rifle of *bona-fide* Government pattern and bearing the Government Viewer's marks. These rifles must be used as issued, and no checkering on the underside of the fore-end is permitted. The windage must be set centrally, and any adjusting screw must not be used. The sights must be used as issued. The sling must not be used for steadying the rifle. The trigger weight must not be less than 5 lb.

The fore-ends of privately owned No. 1 rifles may be packed so as to increase accuracy of shooting by regulating the vibrations of the S.M.L.E. barrel, and this packing may include metallic fittings not exceeding 2 oz. in weight, if such fittings are submitted to the N.R.A. before use in competition at the Bisley meeting.

No. 3 Patt. '14 rifles may have the following adjustments. The action should be bedded so that the rear face of the recoil lug, the underside of the body at the front and rear ends, and the reinforce of the barrel bear definitely on the stock. The barrel at the muzzle end should bear lightly against the stock when the body and the reinforce bearings have been correctly adjusted. There is, however, no objection to the floating out of the fore-end to allow the barrel to be completely free at the muzzle should it be so desired. The clearance given by floating out should be kept to a minimum. Also a bearing may be obtained between the two lightening cuts approximately 6 inches forward of the body.

This bearing should be obtained by building up the fore-end at this point by means of a light metal shim or wood insert glued in position. From this point forward the muzzle of the barrel should be clear of all furniture.

Bearing surfaces mentioned above may be restored or built up by inserts or liners of *wood* and *glued* in place. No material other than wood may be employed for this purpose except plastic wood, which may be used if restricted to the above-mentioned points. To avoid unnecessary insertions of wooden blocks, one or two small pieces of thin paper may be used for the fine adjustment of any bearings at, or in the rear of, the reinforce.

The length of the guard screw collars should be such that the trigger guard is tightened against the face of the collar and also the stock. There is no objection to the use of collars slightly thicker in the wall for either the front and/or rear trigger-guard screws, provided always that the external dimensions of the present collars are not exceeded. It is essential that the external dimensions of the collar should remain unaltered, as enlargement of the holes for the collars in the woodwork is objectionable and cannot be permitted.

The barrel may be freed in the stock by floating out the woodwork.

No. 4 rifles may be stocked up as follows. The fore-end should fit tightly at the rear end between the sear-lugs and the butt-socket of the body. There should be a good bearing on the body surface around the front trigger-guard screw hole and along the narrow ledge on each side of the magazine opening, extending for a distance of not less than 1½ inches to the rear of the front trigger-guard screw hole. This bearing should be even throughout its surface, and the fore-end should be clear on either side of the barrel socket of the body—*i.e.* immediately in rear of the reinforce. There should be a good bearing of the reinforce of the barrel extending for its full length. The seating should be approximately one-third of the width of the reinforce. This bearing should be in the centre of the reinforce seating of the fore-end.

There are three permissible methods of stocking-up :

1. The muzzle end of the barrel should bear for the full length of the cap fore-end and be in the centre of this raised

seating. There should be a clearance of not less than ·02 inches between barrel and either side of the fore-end for the length of the seating. When assembled the lift required to raise the barrel from this seating should be 3 to 5 lbs. The barrel should be otherwise entirely free from influence of the fore-end and should have a clearance of approximately 0·10 inch.

2. Instead of a bearing at the muzzle end, the barrel seating may be "floated out", leaving a clearance all round the barrel. The barrel should be free of influence from the fore-end forward of the reinforce and have a clearance of approximately 0·10 inch.

3. A bearing should be obtained between the two lightening cuts in the stock fore-end, approximately 5 inches forward of the body. This bearing should be obtained by building up the stock fore-end at this point by means of a 1½-inch light metal shim or a wood insert glued in position. From this point forward to the muzzle the barrel should be clear of all furniture, with a clearance of approximately 0·10 inch.

As in the case of the 1914 pattern rifle, bearing surfaces may be restored or built up by wood inserts or liners glued in position or plastic wood confined to the positions mentioned, or small pieces of paper for fine adjustment.

The length of the guard-screw collars should be such that the trigger guard is tightened against the face of the collar and also the stock.

There is no objection to the use of collars slightly thicker in the wall for either the front and/or rear trigger guard screws, provided always that the external dimensions of the present collars are not exceeded. It is essential that the external dimensions of the collar should remain unaltered, as enlargement of the holes for the collars in the woodwork is objectionable, and cannot be permitted.

The barrel may be freed in the stock by floating out the woodwork.

The trigger mechanism of rifles made before 4th December, 1947, may be altered to comply with design D5/E/5021/SK168, which differs from the former in that the trigger is hung on to the body instead of on the trigger guard. The bracket to which the trigger is fitted may be integral with the body or brazed on.

Service Rifle Class (*b*) includes rifles as defined under Class S.R. "A", except that residents of Australia or New Zealand may

FIG. 69.—SHOOTING IN THE BACK POSITION WITH THE MATCH RIFLE ON THE STICKLEDOWN RANGE, BISLEY.

use the Commonwealth rifle No. 1 Mk. III (H). The sling may be used provided it is attached to the rifle at not more than two points, does not exceed 2 inches in width or ¼ inch in thickness

and is not passed round any part of the competitor's body other than one arm and/or wrist (a hook or button may be sewn to the shooting-coat to prevent the sling from slipping down the arm); the wind-gauge may be used and adjusted; an aperture backsight, fixed in accordance with the regulations of the N.R.A., may be used, and may be provided with a single lens and/or filter.

A heavy barrel of the approved N.R.A. design may be fitted to the S.M.L.E. No. I rifle. The leaf backsight and bed of privately owned S.M.L.E. No. I rifles may be removed and the handguards made continuous.

FIG. 70.—THE RUNNING DEER RANGE, BISLEY.

The deer is seen running between the two white posts. Above are the dummies on which the shots are signalled.

Sniping Rifle means any military or central-fire sporting rifle which has a telescopic sight, all the lenses of which are contained in one tube or unit. Weight, trigger pull and ammunition must be as required for sporting rifles.

Match Rifle includes any military or other ·303 breech-loading rifle which bears (when of British make) proof marks on both barrel and breech, and which has a barrel weighing not more than 3½ lb. A minimum trigger pull of 4 lb. is permitted, all kinds of sights are allowed, and a rubber heel-plate may be used. When the match rifle is used in the prone position, the competitor may use some form of rest for the wrist or back of the forward hand,

and the toe of the butt may be rested on the ground as in the official "Hawkins" position. The ammunition used must, in the opinion of the Bisley committee, be serviceable from a military point of view.

Sporting Rifle means any single, double or repeating rifle of any calibre or weight, provided that single rim-fire rifles of ·250 calibre or under must not exceed 7½ lb.; central-fire rifles of ·250 calibre or under must not exceed 8½ lb.; over ·250 and not

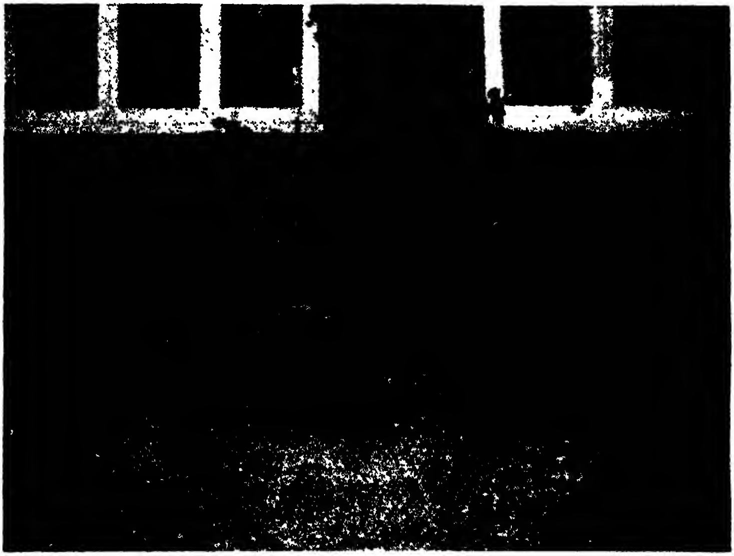


FIG. 71.—ONE OF THE ORIGINAL STEEL RUNNING DEER TARGETS MADE TO A DESIGN BY LANDSEER.

These were disused because of ricochets, and are now replaced by penetrable targets.

exceeding ·476, 10½ lb., and over ·476, 14 lb. Double rifles may exceed single rifles of similar calibre by 4 lb. The weights are exclusive of the weight of any telescopic sight. Combination weapons incorporating additional smooth-bore barrels may weigh 1 lb. more than the maximum permitted for any particular class or calibre.

The sporting rifle may have a minimum trigger pull of 2½ lb. Any sights may be used, and any ammunition may be used, except

that British service rifles must use service rifle Mk. VII ammunition as issued by the N.R.A.

Two-twenty Small-bore Rifles. The N.R.A. includes in this class all rifles having barrels not exceeding 30 inches in length, while the N.S.R.A. specifies the small-bore rifle as a rifle of calibre not exceeding ·22 and of any pattern that can be (and in competition must be) loaded singly. Both associations require that the trigger pull shall not be less than 3 lb. and, except in special competitions, iron sights must be used, although a single lens or colour filter may be attached to the backsight only.

The ammunition for small-bore rifle shooting is specified by the N.R.A. as ·22 Short, Long and Long Rifle cartridges with lead bullets, while the N.S.R.A. permits any ammunition not exceeding ·23 calibre, overall cartridge length of 1·1 inch, and lead or lead alloy bullet weighing not more than 40 grains. It will be noted that these rules permit not only the standard ·22 Long Rifle ammunition, but both low-, medium- and high-velocity Short, Long and Long Rifle cartridges. Such ·22 cartridges as the Hornet are excluded from all small-bore competition shooting, but have their possible uses in some of the Bisley competitions open to various calibres—*e.g.* sniping and sporting rifle competitions.

Small-bore Rifle Sights

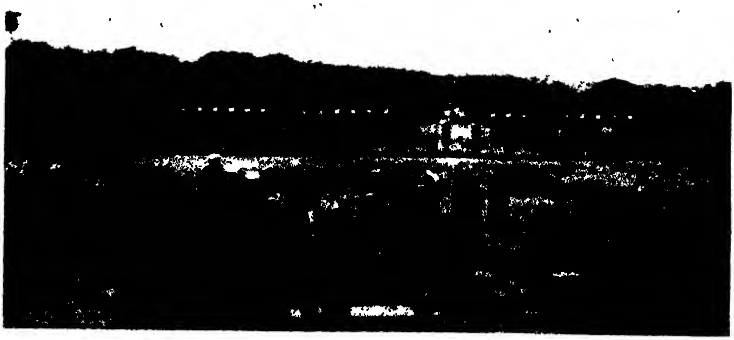
The N.S.R.A. recognizes four types of sights :

1. *Open sights* including barleycorn, blade or solid bead foresight with or without protecting ring not exceeding ¼ inch in width and service pattern backsight with V, U or bar with or without windage.

2. *Aperture sights* with ring or blade foresights and aperture backsights. With these celluloid or similar foresight elements may be used, and a single lens may be fixed in the backsight in lieu of spectacles. No combination of lenses is allowed but tinted filters are permitted.

3. *Telescopic sights* including any form of telescopic or optical sights. These are permitted only in special competitions.

4. *Any sights.* This term includes the use of any of the sights previously mentioned and applies to certain competitions only.



THE TARGETS APPEARED.

THE TARGETS DISAPPEARED

FIG. 72.—REVOLVER SHOOTING IN THE GRANET COMPETITION ON THE CHEYLESMORE RANGE, BISLEY.

The man-size silhouette targets appear for one second.

Revolvers and Pistols

Revolvers used in N.R.A. "Revr" competitions at Bisley must be suitable for military purposes and for use with Government ammunition. The calibre must be the minimum diameter of bore that will take ·45 or ·38 ammunition. The barrel length is limited to a maximum of 7½ inches and the trigger pull to a minimum of 4 lb. Butt plates must be symmetrical, so that the weapon can be used with equal efficiency in either the left or the right hand, and there must be no indentation other than normal

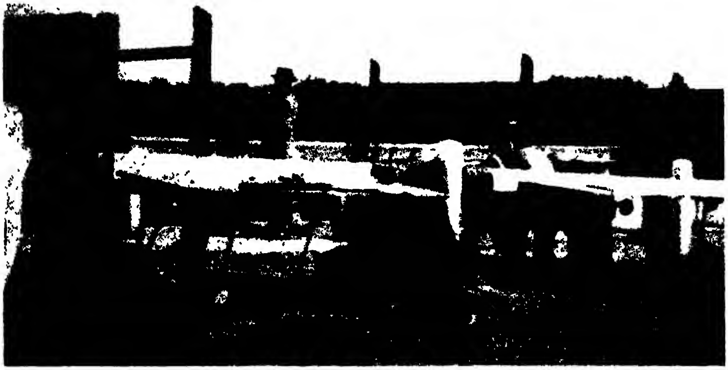


Fig. 73.—Part of the Revolver Range, Bisley.

checkering. Revolver sights must be solid enough to withstand rough usage and, apart from those of ·22 pistols and revolvers, must not be capable of adjustment during shooting.

Single-shot and semi-automatic pistols of calibre between ·455 and ·32 may be used with any type of sight or suitable ammunition. The only restrictions are that the trigger pull must not be less than 4 lb. and that the butt-plates must be symmetrical and have no indentations other than normal checkering. Padding and/or whipping of butts is not permitted.

Single-shot or semi-automatic pistols or revolvers for ·22 ammunition must not take a cartridge more than 1·1 inches overall length or be used with a bullet of more than ·23 diameter

FIG. 74.—WATCHING THE KING'S HUNDRED, BISLEY.

and 40 grains weight. The barrel length must not exceed 10 inches, the sights must be not more than 10 inches apart, and the trigger pull must not be less than 2 lb.

The weapons used in N.S.R.A. competitions are ·22 pistols or revolvers, including any single-shot or self-loading pistol or revolver chambered for ·22 rim-fire cartridges, having a barrel length (including cylinder) of not more than 10 inches, open sights not more than 10 inches apart, and a trigger pull of not less than 2 lb. Sights may be adjustable. The grip may be of any type provided that no part of it or attachment to it extends beyond the hand to the wrist or gives any support by the wrist of fore-arm. Shooters may use any normal or coloured shooting spectacles. Orthoptics are allowed.

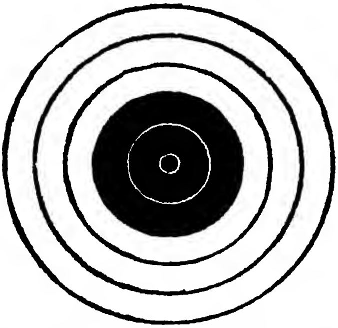
In free pistol competitions there is no restriction of barrel length, trigger pull or sights except that sights must not contain a lens or glass of any description.

Targets, Scoring and Signalling

At the time of writing, Bisley competitions are shot at the ranges of 200, 300, 500 and 600 yards at the " 1949 " target, which is circular, coloured very light grey in the upper half and sand colour in the lower half. Competitions at other ranges, apart from exceptions, are shot at " Bull's-eye " targets, which are white with black bull's-eyes. Revolver targets include both grey and white cards with bull's-eyes, semi-circular black aiming marks or special figures.

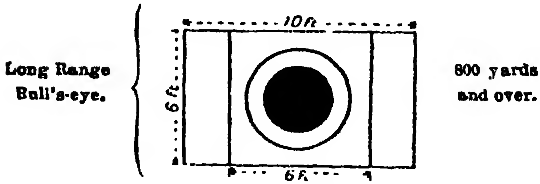
In all competition shooting, when a shot touches a line between two divisions on a target, the value of the higher division is scored.

On the full-bore ranges at Bisley the results of the shots are signalled after each shot. The target is lowered and a " dummy " is raised in its place. This is a frame on which is hung a black square which shows the score in accordance with the code illustrated in Fig. 75. Then the dummy is lowered and the target raised after a spotting disc has been placed over the bullet hole. This is a circular disc black one side and white the other, and of sufficient size to be easily seen through a spotting telescope. The black side is exposed when the bullet hole is on the white part of the target, and the white side when the bullet hole is in the black. Its purpose is to show the position of the last shot fired for the



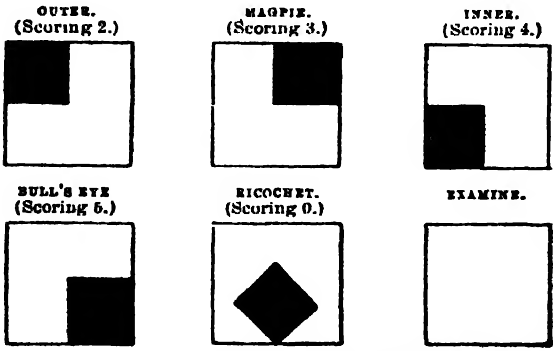
[*By courtesy of The National Small Bore Rifle Association.*

N.S.R.A. 15-YARD TARGET (ACTUAL SIZE.)
The smallest circle is the ten-ring.



[*By courtesy of The National Rifle Association.*

DIMENSIONS OF N.R.A. LONG RANGE TARGET.



[*By courtesy of The National Rifle Association.*

SIGNALLING ON BISLEY RANGES.

FIG. 75.

guidance of the shooter, as bullet holes are quite invisible through the telescope at long range.

Complete misses are not signalled, except at moving targets, and spotting discs are not used even when a bullet hits the target, if the throwing up of sand or dirt against the target or into the gallery shows that the shot was a ricochet.

The value of any shot as signalled may be challenged by the shooter, provided that this is done before the next shot is fired on the same target and a deposit of half a crown paid to the range officer. Only if the signalling is found to be erroneous is this deposit refunded.

Marking at moving targets, such as the running deer, is signalled as follows:

Bull's-eye	White Disc
Inner	Red Disc
Magpie	Black-and-White Disc
Outer	Black Disc
Misses	Red-and-White Flag
Haunch of deer—*i.e.* so much of the target as is behind a faint line drawn vertically across the body	Black X

The disc is shown on the dummy so as to indicate the spot struck on the target. Misses are indicated by the flag shown on the middle of the dummy.

N.S.R.A. Target Cards

Quite a large number of different target cards are used in practice and competition small-bore shooting. These include cards with ten targets at each of which one shot is fired: and cards of five targets at each of which two shots are fired, which are printed with proportionately sized bulls and aiming marks for use on 25-, 20- and 15-yard ranges. These include both circular aiming marks and "tin hat" (semi-circular) marks. The 50-yard match card has two targets at each of which five shots are fired. The 100-yard and 300-yard match cards have a single target at which ten shots are fired.

The reason that several targets are printed on one card is that at short ranges bullet holes group too close together for it to be

TABLE 20

Sizes of Scoring Rings for Edge Touching on N.S.R.A. Standard Target Cards

Distance	Scoring ring value	Match cards, in inches	Metric equivalent cards for yard ranges	
			Inches	Millimetres
100 yards	10	2	1·625	41·20
	9	4	3·06	77·78
	8	6	4·52	114·36
	7	8	5·95	150·94
	6	10	7·39	187·52
	5	12	8·82	224·10
50 metres (International)	10	—	—	20
	9	—	—	40
	8	—	—	60
	7	—	—	80
	6	—	—	100
	5	—	—	120
	4	—	—	140
	3	—	—	160
	2	—	—	180
	1	—	—	200
50 yards	10	0·89	0·701	17·80
	9	1·89	1·42	36·08
	8	2·89	2·142	54·36
	7	3·89	2·86	72·64
	6	4·89	3·68	90·92
	5	5·89	4·3	109·20
	4	—	5·02	127·48
25 yards	10	0·335	0·24	6·10
	9	0·835	0·601	15·24
	8	1·335	0·959	24·38
	7	1·835	1[illegible]9	33·52
	6	2·335	1·678	42·66
	5	2·835	2·035	51·80
20 yards	10	0·224	0·148	3·77
	9	0·624	0·437	11·09
	8	1·024	0·725	18·40
	7	1·424	1·012	25·73
	6	1·824	1·298	33·00
	5	2·224	1·588	40·37
15 yards	10	0·113	0·0563	1·43
	9	0·413	0·272	6·91
	8	0·713	0·487	12·39
	7	1·013	0·703	17·87
	6	1·313	0·92	23·35
	5	1·613	1·135	28·83

possible to decide the number of shots on the bull's-eye with any degree of certainty were not the number restricted.

Most targets consist of a black central portion and a white outer portion. The black portion is larger than the bull's-eye * or " ten-ring ", for the bull's-eye itself is too small to be seen clearly at a range distance. In the very centre of the black is a dotted white line known as the " inner carton ", which is used in special competitions in which a shot scored on it counts 10·1 points. (Ten consecutive shots touching the inner carton are known as a " 10X possible ".) In ordinary competition shooting this inner carton is ignored. Outside the inner carton is a continuous white circle which denotes the edge of the bull. Any shot touching the bull scores 10 points. Ten such shots on one card would therefore score 100, and this, being the highest possible score in ordinary shooting, is known as a " possible ".

The value of shots is decided by the edge of the shot hole nearest the centre of the target. As the card tends to close up after the shot has passed through it, whether or not it touches the bull or any of the other rings is decided, in doubtful cases, by the use of a plug scoring gauge which is a metal plug having an outer rim of exactly bullet diameter which, when placed gently in the bullet hole, shows at once whether or not the bullet has actually touched the line.

In pool shooting, scoring is different: the whole of the shot hole must be within and not touching the central ring.

·22 Pistol Shooting

The N.S.R.A. targets for slow-fire shooting with the ·22 pistol are for use at ranges of 50 metres, 50 yards, 20 yards and 10 yards. Timed or rapid fire is shot at a range of 20 yards. The sizes of scoring rings edge touching on N.S.R.A. and N.R.A. standard pistol cards are as given in Table 21.

International Shooting

In the wider field of international shooting, control is exercised by the International Shooting Union (I.S.U.), which holds a World Championship Meeting every four years, and which is responsible to the International Olympic Committee for Olympic

* The term " bull's-eye " or " bull " is used somewhat indiscriminately for the black aiming mark and the 10 ring.

TABLE 21

Sizes of Scoring Rings for Edge Touching on N.S.R.A. and N.R.A. Standard Pistol Target Cards

Distance	Scoring ring value	Inches	Millimetres
N.S.R.A.			
50 metres. Slow fire	10	—	50
	9	--	100
	8	--	150
	7		200
	6	--	250
	5	--	300
	4	--	350
	3	--	400
	2	-	450
	1	-	500
50 yards. Slow fire	10	3·39	
	9	5·54	
	8	8·00	
	7	11·00	
	6	14·80	
	5	19·68	
20 yards. Timed or rapid	10	2·24	
	9	3·76	
	8	5·44	
	7	7·46	
	6	10·08	
20 yards. Slow fire metric	10	0·58	
	9	1·30	
	8	2·02	
	7	2·74	
	6	3·46	
	5	4·18	
	4	[illegible]	
	3	5·62	
	2	6·34	
	1	7·06	
20 yards. Slow fire	10	1·12	
	9	1·88	
	8	2·72	
	7	3·73	
	6	5·04	
	5	6·72	
	4	8·84	
10 yards. Slow fire only	10	0·75	
	9	1·125	
	8	1·50	
	7	3·00	
	6	4·50	
	5	6·00	

TABLE 21—*continued*

Distance	Scoring ring value	Inches
N.R.A.		
50 yards	6	3·00
	5	5·00
	4	8·00
	3	12·00
	2	16·00
	1	24·00 sq. (remdr. of target)
20 yards	6	1·25
	5	2·00
	4	3·50
	3	5·50
	2	7·50
	1	13·50 sq. (remdr. of target)
10 yards	6	0·75
	5	1·50
	4	3·00
	3	4·50
	2	6·00
	1	13·50 sq. (remdr. of target)

Games shooting events. Thus each two years Olympic Games and I.S.U. World Championships are arranged. The N.S.R.A. represent Great Britain on both organisations, and where the high-power rifle shooting events are concerned receive the co-operation of the N.R.A. by the use of their Bisley ranges.

CHAPTER XIX

RANGE CONSTRUCTION AND RIFLE CLUB FORMATION

It is not practicable to make every range absolutely secure against the escape of shots into the surrounding countryside, for open-air ranges cannot be roofed over with bullet-proof material, and some reliance must be placed on the proper behaviour and reasonable skill of the shooter. On occasions a recruit has put a shot over the butts, and in one instance a range was closed for this reason. But such an occurrence is rare and due to an accident, not to lack of skill, for the poorest shot should be able to get near enough to the target to avoid shooting near the top of the butt at a range of 220 yards. Shooters have to qualify before being allowed to fire at the longer ranges.

Safety on small-bore ranges of up to 25 yards, particularly indoor ranges, is more easy to provide, for at short distances comparatively low butts cover a very wide angle of error in aiming, and very great thicknesses of material are not necessary to stop the ·22 Long Rifle lead bullet.

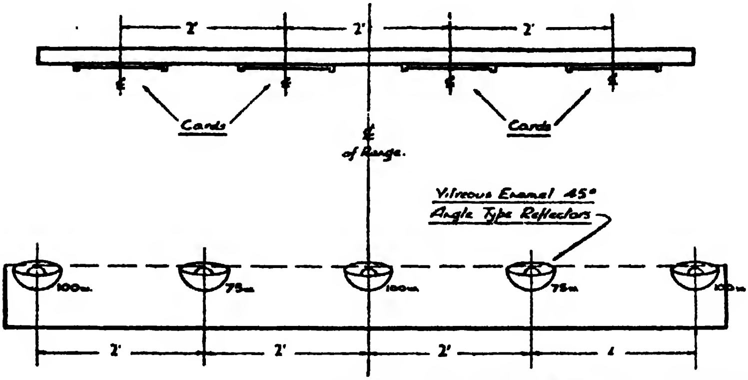
The Construction of Indoor Ranges

The standard ranges are 25, 20 and 15 yards, 25 yards being adopted wherever practicable, the shorter distances when a sufficiently large room or building is not available. In order that clubs having ranges of different lengths may compete one with another, proportionate targets are issued by the N.S.R.A.

The width of building or room should not be less than 6 feet for one target, plus an additional 3 feet for each additional target; and where there are more than three targets a width of 4 feet per target is desirable, although not considered essential. For example, if the room is 12 feet wide, three targets and firing positions are possible; if it is 15 feet wide, four targets may be fired at simultaneously, but the space is somewhat restricted. Generally, the height of the building should be 10 feet.

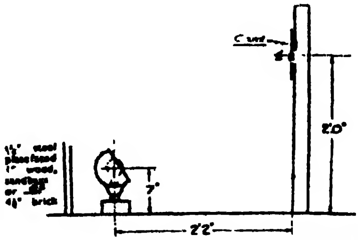
At the butt or target end of the range there must be a wall of at

least 4½-inch thickness of brickwork or concrete, and this must be protected preferably by a steel plate of not less than $\frac{3}{16}$-inch thickness and 3 feet wide, and of horizontal length not less than 2 feet for every target, plus an additional foot at each end. The plate should be placed at an angle of between 60° and 45° to the horizontal so as to deflect the bullets downwards into a sheet-



[*By courtesy of The National Small Bore Rifle Association.*

FIG. 76.—PLAN OF LIGHTING FOR INDOOR TARGETS.



[*By courtesy of The National Small-Bore Rifle Association.*

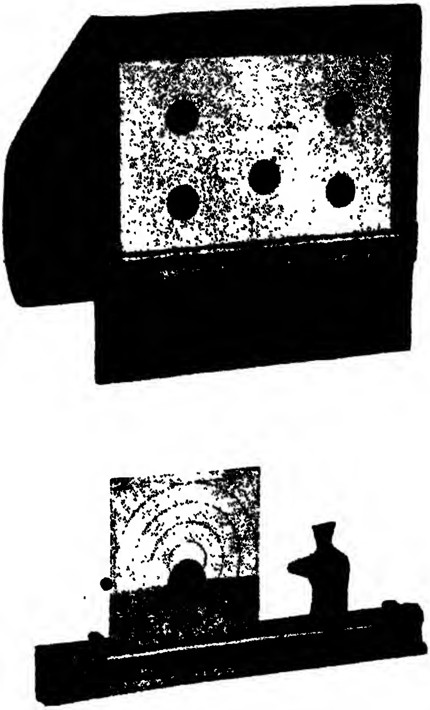
FIG. 77.—SECTION SHOWING ARRANGEMENT OF LIGHTING FOR INDOOR TARGETS.

steel trough filled with sawdust or fine sand. If this protection cannot be provided, a sand-butt will satisfy War Office regulations.

The targets are fixed 2 feet apart centre to centre in wooden frames or special target holders (see Figs. 76 and 77), the centre of each card being 2 feet above floor level. They are illuminated by electric lamps, which are fixed 7 inches above floor level and 2 feet 2 inches in front of the target, and protected by a 4½-inch

brick wall or a thickness of other material adequate to stop an occasional stray bullet. The standard intensity of illumination is 40 foot-candles on the card as recorded by instrument.

The firing-point should be flat and at ground level. A space



[*By courtesy of Messrs. Parker-Hale, Ltd.*

FIG. 78.—*Above:* STOP BUTT AND BULLET CATCHER FOR ·22 RIFLE OR PISTOL PRACTICE.

Below: GRAVITY "ROLLER" TARGET HOLDER.

of 4 feet width is allowed for each man, and a depth of not less than 7 feet from front to back. The firing-points should be marked out by white lines. Here the floor should be kept clean, and matting of coconut fibre or other suitable material provided.

An upstairs rifle range should have a floor which is proof against occasional stray shots.

Construction of Outdoor Ranges

Outdoor ranges for small-bore shooting are usually 100, 50 and 25 yards, also 50 metres (approximately 54½ yards). They should be located so that firing is in a north-easterly direction, in order that the shooters never have to face the sun.

Where it is possible, the various ranges are placed side by side with separate butts and firing-points in order that shooting may take place at all ranges concurrently. But if space is limited one butt may have to serve for all distances, the firing-points being

Fig. 79.—On the 100-yard Range, Ham and Petersham Rifle Club.

placed at 100 yards, 50 metres, 50 yards and 25 yards from it. Then, of course, shooting is restricted to one distance at any time.

Butts can be constructed of brickwork, timber-boxing filled with sand or gravel, or other bullet-proof structure. They should be 15 feet high if the range exceeds 50 yards but does not exceed 100 yards, or may be reduced to 12 feet high if the maximum range is 50 yards. They should extend laterally 10 feet beyond the target if the range exceeds 50 yards but does not exceed 100 yards, or 6 feet if the range does not exceed 50 yards.

A sand-pit makes a good natural back stop, but a hard rock quarry is not safe because of ricochets: a bullet striking a rock

face at an angle of 45° and rebounding to another rock-face at right angles to the first can come back and hit the shooter.

Where the back stop is the face of a sand-pit, or a thick bank of earth with almost vertical face, no additional bullet trap is necessary. But where the back stop is a wall sufficient to stop occasional shots but capable of being penetrated by concentrated fire at one spot, an additional bullet trap as described for indoor ranges, or alternatively a solid earth bank of not less than 3 feet thickness and 5 feet height should be provided. For it should be remembered that while a single bullet is not difficult to stop, shots concentrated on a bull do not take long to pound their way through a brick wall or even a steel plate of moderate thickness.

Another point to be kept in mind is that ricochets may pass over the top of the butt. To prevent these all stones should be picked up and removed from an open-air range.

As in the case of indoor ranges, the targets are placed 2 feet apart centre to centre. It is recommended that for the average club four targets at each distance are sufficient.

To permit shooting in comfort in all weathers, the firing-point, where practicable, should be roofed over and provided with a slightly raised floor or platform, which should slope backwards not more than 3 inches in 7 feet, and should have a 2-foot wide level platform in front for telescopes.

Open-air ranges should be carefully fenced to prevent trespassers from straying into danger.

Pistol Range Construction

It is necessary that on all ranges designed for ·22 rifle shooting, which it is desired to use for ·22 pistol shooting, consideration should be given to the following :

(*a*) Precaution that any fittings such as gas or electric light fittings, pipes, conduit and brackets, also girders and such like, shall be so protected that bullets cannot bounce back nor glance off.

(*b*) On uncovered ranges, if there is a chance of loose shots being fired over the stop-butt on to a flank, safety may be secured by construction as follows :

(i) A vertical wooden board of 9 inches × 2 inches or thicker material, the bottom edge 6 feet from the ground ;

the distance from the shooter's side of the table to the board to be not more than 4 feet.

(ii) Baffle boards impenetrable to high-velocity ·22 ammunition between the firing-point and the existing butts in such positions as to completely block any daylight that may show on a sight line drawn from the top of the butts to a point 5 feet above the ground immediately behind the table.

Official Approval of Ranges

To be able to obtain the benefits of exemption of payment from gun licence duties for the club and its members, and to permit the club's members to use the club's ammunition and rifles when engaged in target practice without holding firearms certificates, the range must be approved for safety by the Army Council, after which the N.R.A. or the N.S.R.A. can apply to the Home Office for approval of the club.

A club, being desirous of having their range inspected by the competent military authority with a view to the issue of a Safety Certificate, should make application to the secretary of the central organization (N.R.A. or N.S.R.A.) to which it is, or will be affiliated, for arrangements to be made for inspection.

Before a range is constructed proper drawings should be prepared, showing the range in plan and section to a scale of about ⅛ inch to 1 foot, and details of the butts and targets to a larger scale. In the case of an outdoor range the position should also be indicated on a 6-inch-to-the-mile Ordnance Survey map. Prints of these drawings and copies of the map can then be submitted to the local authority and the chief officer of police of the district in which it is proposed to site the range.

The application must be accompanied by a letter from the local district council in whose area the range is situated to the effect that the proposed range will not infringe any local byelaw; also a letter from the chief officer of police of the district in which the proposed range is situated, stating whether or not there is any objection to the site selected and, if the proposed site is on licensed premises, whether or not there is any objection on the part of the Licensing Justices.

Should the Licensing Justices make any stipulations regarding a range, the application must be accompanied by an undertaking

by the applicant that these stipulations will be complied with. Application for the inspection or ranges cannot be entertained when they relate to ranges on licensed premises except where there is an entrance to the range separate from the entrance to the licensed premises, and then only on the understanding that no alcoholic liquor will be sold on the range.

CHAPTER XX

MARKSMANSHIP

RIFLE SHOOTING differs from many other sports in that a high degree of proficiency can be attained by anyone of reasonable intelligence and normal physical make-up. There is no need for a special aptitude, nor is it necessary to begin early in life. All that is necessary is to understand what one is doing, to be aware of one's mistakes and to persist until they are overcome.

THE ESSENTIALS

There are three essentials to rifle shooting: steady holding, aiming correctly and releasing the trigger in such a manner that the hold is not disturbed at the time of aim. These can all be learnt on the indoor range of fixed length. Making allowance for wind deflection, judging range and allowing for bullet drop, and shooting the right amount ahead for running game may be acquired later in the field; but field practice cannot be relied upon to make up for a bad hold or jerky trigger release.

MASTER EYE

Before considering the position to be adopted, a new-comer to shooting must determine which is his master eye, for this, and not his capability with his hands, decides whether or not he will shoot from the right or left shoulder. Most people have one eye stronger than the other, and this is the eye which should be in line with the sights when a rifle is used, or in a line with muzzle and point of aim when shooting with the shotgun. Some game shooters shoot with both eyes open, in which case it is essential that the master eye should be used in sighting: some close one eye slightly or completely so as to let the other distinctly see the sights and target.

When beginners are being trained, the instructor should first find out which is the master eye and then tell the pupil to shoot from the appropriate shoulder. An easy way of finding out which eye is the stronger is for the instructor to close one of his own eyes and ask the pupil to hold a finger so as to conceal the

instructor's eye : this finger will then be held between the instructor's eye and the stronger of the pupil's eyes. Only when this has been decided, should practice in shooting commence.

Holding

The first of the three essentials to be learnt is steady holding, for until the foresight can be held on the target, a correct aim is impossible. In these days the gun sling is used in nearly all shooting where a close aim is required, for a sling properly adjusted makes a considerable difference to steadiness. Some people advocate practice for beginners using a sand-bag rest for the forearm, on the grounds that it gives confidence. But this is quite unnecessary, and only puts off the day when the sling must be used.

The Shooting Sling

A carrying sling is part of the normal equipment of a service rifle. Its use is permitted in most competitions to steady the rifle during shooting, and when used for this purpose the lower swivel is moved from the butt to a position just in front of the action. Small-bore target slings (of ordinary English pattern) are normally attached by swivels to eyes fixed at the extreme front and back ends of the fore-end : American slings are attached to the fore-end at one point only.

The usual manner of using the sling is to place the left elbow through the loop and then pass the left hand round in a clockwise direction so as to grasp the fore-end. The (English) sling then passes from the foremost swivel under the back of the left hand, across the right of the wrist, over the forearm from left to right behind the upper arm, and then back to the hindmost swivel. The sling should be pushed up the arm as far as it will go towards the armpit; and to keep it in this position it is permissible for a button or belt-hook to be sewn on to the shooting-jacket.

When the rifle is brought to the shoulder, the tension of the sling takes its weight, at the same time pulling the butt into the shoulder. The left hand tends to slide forwards on the fore-end, but in small-bore competition it is permitted to fix a hand-stop on the fore-end which takes the thrust of the hand. It is then found that with the support of the sling and the left hand the rifle stays

in position, the butt in the shoulder and the fore-end resting on the left palm without any necessity for it to be gripped by the left hand, or the right hand used at all (see Fig. 80).

New-comers to rifle-shooting find the sling uncomfortable and distracting, but with time and practice they learn its advantages, for shooting with a sling is, in the end, much less tiring than holding a heavy rifle without support, and makes much greater accuracy possible.

It is important that the sling should be properly adjusted for length. This is found by trial and error. Generally, the shooter begins by adopting too high a position; but he learns to get lower down and refixes his hand-stop farther and farther forward until a good low position becomes natural. A sheepskin glove or mitten may be worn on the left hand to protect it from the pressure of the hand-stop and to reduce the tendency to grip the rifle.

The American sling differs from the English pattern, for it consists of a loop which is attached to the fore-end, passes under the left hand and round the upper arm and back again to its point of connection. For use in carrying the rifle it is attached to a single strap (the tail piece) which continues on and connects to the swivel on the butt. This strap is detached or hangs loosely during shooting. Fig. 28 illustrates a Parker–Hale sling of similar type. Slings of this type are serviceable alike for target-shooting or for shooting game or vermin at long range.

The Parker–Hale Cuff Sling consists of a cuff which straps on to the upper arm and normally is left in position all the time. A short strap which is fastened to the front swivel hooks on to this cuff when the shooting position is adopted.

Slings are made of either leather or webbing, and both materials serve well, although opinions differ as to which is the better. The width and thickness of material are restricted to 2 inches and ¼ inch respectively by competition rules.

The Prone Position

The prone position is most often used in target shooting, particularly with the small-bore rifle, for it permits steady holding and accuracy of aim which cannot be equalled except in the back position, which is used in competition in "match-rifle" shooting only.

When prone, the shooter should not be in line with the direction of aim, but should adopt a position with the body at 45° to the rifle, with the legs apart and, unless this proves unduly difficult, with the heels flat to the ground. The fore-end of the rifle should rest on the left hand and, except when a sling is not used, it should not be gripped: the rifle should just lie on the heel of the left hand and be pulled into the shoulder by the sling, while the left hand should thrust against the hand-stop (see Fig. 80).

FIG. 80.—THE PRONE POSITION.

The left hand is held open to show that the rifle is supported by the sling.

The left elbow should be as far underneath the barrel as the shooter finds possible. At first this proves difficult and uncomfortable; but with practice the position improves. With the cuff type of sling the position of the left elbow is of more importance than if the ordinary English sling is used.

Having got into position, the shooter should close the eyes and adopt the shooting position, then look through the sights and see where they are pointing. If they are not on the target, he should move his *whole body* to bring them into line.

Effect of Canting the Rifle

The rifle must be held upright. When a blade foresight is used it can be kept vertical, provided there is not some slightly out of vertical line in the foreground which deceives the shooter. An aperture foresight is often used in conjunction with an insert, which gives a horizontal line below the aperture, the purpose of which is to help the shooter to keep his rifle vertical.

The effect of canting the rifle to left or right is to throw the shots to left or right respectively and also low on the target. The lateral error increases with range and elevation, and becomes very serious at long range or with ammunition of high trajectory. Its amount can be calculated by the following working rule:

> " Multiply the elevation in degrees by the cant in degrees to obtain the lateral deflection in minutes."

Sighting

The aperture foresight is used in conjunction with the aperture backsight for small-bore target shooting, and with this combination the aim is correct when the aiming mark is centred in the aperture foresight with an even ring of white all round it. When using a blade foresight the correct aim is the " 6 o'clock " aim, in which the blade foresight is held just below the underside of the aiming mark, a slight amount of white being visible between the aiming mark and the sight.

It has been said that the advantage of the peep-sight is that the eye automatically adopts the right position and looks through the centre. This is not altogether true, and the shooter may find it necessary to ascertain whether or not he is looking through the centre of the aperture: when the eye is out of line the bull becomes blurred or may fade out. (Fade-out of the bull, however, is not always due to this cause: eye fatigue has the same effect.) The shooter may also observe a dark spot in the centre of the aperture, which is caused by the combined optical properties of the aperture and the eye, and for this reason he may find it convenient always to place the bull slightly off centre.

Next, the elevation should be obtained by breathing in, which causes the bull to rise above the foresight, then letting out the breath until the bull is centred in the foresight ring. At this stage

the hold should be steadied by the right hand,* the hand of the rifle firmly gripped and, when the bull is apparently motionless in the centre of the foresight ring, the trigger slowly squeezed until the sear is released and the shot fired.

Calling the Shot

The shooter does not then immediately look through his spotting telescope to see where the shot has gone, but "follows through" by maintaining his position. When the rifle recoils, the muzzle lifts, disturbing the aim; but if the hold is correct the rifle falls back into the same position in which it was before the shot was fired, in which case the shooter should see the aiming mark in line with his sights as soon as the wobble caused by the recoil has ceased.

In addition to following through, the shooter should *call the shot*—*i.e.* be aware of any error which he may have made. If, for example, the trigger release occurred at a moment when the rifle had swung a little off the mark, the shooter should estimate the position of the bullet hole on the target before looking at the target.

Between shots the fired case must be extracted, the target examined through the telescope and a new cartridge inserted. During these actions the shooter should take a number of deep breaths so that he will not have difficulty in holding his breath while taking aim for the next shot. If, however, he does find that he has not got a steady sight on the bull before wanting to breathe again, he should relax, take a few more breaths and then re-sight, as otherwise a bad aim may result.

Practice on the range is supplemented by "dry shooting"—*i.e.* practising holding, aiming and trigger release without ammunition. This can be done at home, and differs only from shooting on the range in that there is not the result of the shot to show whether or not a perfect release on a correct aim has been made, and there is no sight adjustment to be considered.

Sight Adjustment

The procedure of sight adjustment on the range is simple. When using an unadjusted rifle, a group of a few shots should be

* Some shooters adopt the practice of lining in the sights on the centre bull of the card, using the left hand only, and then, when the aim is accurate, taking hold of the hand of the rifle with the right hand and steadying the aim.

fired. If the centre of this group is an inch low and an inch and a half to the right of the centre of the bull at 100 yards range, the backsight will have to be raised by about four clicks upwards and moved six clicks to the left, or a proportionately lower number for a shorter range.

Other Shooting Positions

Rifle shooting could be made more interesting and more practical if, instead of there being competitions open to the few who care to shoot in the sitting, kneeling and standing positions, shooting in all positions was made obligatory in the major events. For, after all, while shooting prone is ideal for the learner and not without use in war, most shots at game are taken in other positions, and a rifleman cannot be considered expert unless he can shoot standing, sitting or prone, and either in deliberate slow fire or rapidly and at moving objects.

Sitting Position

The sitting position is very useful to the sportsman, for it permits steady holding without the necessity for getting close to the ground. It can be adopted more quickly than the prone position, and is more generally useful because the slightly higher

Fig. 81.—The Sitting Position.

position of the rifle is often sufficient to clear low vegetation. It is particularly convenient for shooting downhill.

The position adopted is with the left shoulder towards the target (in the case of an ordinary right-handed rifleman), the elbows or the upper portions of the arms resting on or inside both knees. The legs are extended with the feet not too far apart and

the heels dug into the ground. The position can be varied to suit the shooter or the ground on which he is sitting, but it is important that the left elbow should be well under the rifle. One variation of the sitting position is for the legs to be crossed.

Competition requirements are that the weight of the body should be supported on the buttocks and feet only, no other portion of the body touching the ground, while the rifle is supported by both hands and one shoulder. The left hand must not rest on a leg or knee. If the legs are crossed, the ankle bones must be in front of a vertical line drawn from the front of the knees to the ground (see Fig. 81).

Kneeling Position

The kneeling position is of very limited utility, for it is not particularly steady or comfortable. The weight of the body is supported on the right knee and foot and on the left foot, and in competition no other part of the body is allowed to touch the ground, although sitting on the side of the foot instead of on the heel is permitted. The left elbow rests just inside the left knee; the right elbow is free of all support. In competition, a knee pad not extending more than 4 inches above or below the knee and a cylindrical instep cushion 8 inches long and 4 inches or 6 inches diameter may be used.

Standing or Offhand Position

The standing position, or offhand position, is the most difficult of all, but it cannot be neglected by a practical shooter because it is extremely useful in the field. In target shooting the hip rest position, in which the left elbow is rested against the body or on the hip, is usually preferred, and in competition the use of a palm rest is permitted to assist this method of holding (see Fig. 82). For military and sporting shooting, the hip rest position is not much used, because it does not permit control of the rifle during rapid fire or in leading moving objects. For these purposes the left arm is extended with the elbow free from the body and under the rifle, while the right elbow is raised. In shooting in the standing position, the left side is turned towards the target, the feet comfortably apart.

In the standing position holding on the mark and squeezing off

the shot are not possible, for the foresight swings all round and across the bull. What the shooter has to do is to attempt to limit the swing to a minimum, to add to the pressure on the trigger

[By courtesy of Mr. H. Worth.

FIG. 82.—HIP REST STANDING POSITION, USING PALM-REST.

as he comes on to the mark, hold the pressure as the sights swing away, and increase the pressure again as he comes on the mark again, until the rifle is fired.

BACK POSITION

The back position is the steadiest of all positions once proficiency in it has been acquired, because the barrel of the rifle is rested on the leg and the butt in the armpit, and the shooter is supporting the rifle with parts of his body that have comparatively little tendency to wobble. This is why the back position is used in match rifle shooting, the purpose of which is to ascertain the barrel and ammunition most suitable for military requirements.

The shooter lies on his back with his left knee bent up, his right knee bent and pointing towards the right. The left foot is placed under the right leg just below the knee. The barrel of the rifle rests on the inside of the right leg. The rifle is held in

the right hand only and is pulled into the right armpit. The left hand is frequently used to support the shooter's head when aim is being taken (see Fig. 69).

In match rifle shooting, the backsight, which is either an aperture or an optical sight, is mounted high on the extreme rear of the butt so as to bring it near to the eye.

Windgauging

The effect of wind is to blow the bullet sideways when the wind is blowing across the range, and to a lesser extent cause a high shot if the wind is towards the target, or a low shot if it is blowing in the reverse direction.

Wind direction is described in terms of a clock face lying upwards on the ground with 12 o'clock towards the target. Thus, a 9 o'clock wind is from the left and a 3 o'clock wind from the right, a 12 o'clock wind from the target and a 6 o'clock wind towards the target.

Windgauging is a matter of experience and common sense. In target shooting experience of the particular ranges comes in, for often the wind does not blow consistently in one direction throughout the extent of the ground over which the bullet has to pass. At Bisley and many other outdoor ranges flags are provided which indicate by the direction in which they point and the angle at which they hang the direction and strength of the wind. But it is not uncommon for the flags on the same range to point in different directions, or some to blow out while others hang down. This is where local experience comes in.

On hot days mirage can be seen in front of the target with the aid of the spotting telescope, and can be used for determining the velocity of winds of less than twelve miles per hour. Mirage is said to be "boiling" when the wavy lines or quiver of the air travel vertically upwards; and "running" when they move laterally across the target.

Snap Shooting

Practice at deliberate shooting at fixed ranges is a necessary preliminary to other forms of shooting because it is in deliberate fire that proper holding and trigger squeeze are learnt. To very many shooters in England, target shooting at fixed ranges is the beginning and end of the sport and the limit of their interest.

But practical shooting at game or in war consists largely of snap shots taken at moving or disappearing targets, or series of shots fired in rapid succession after the first has failed to hit the mark.

In the practice of snap shooting the rifle is brought to the shoulder at the same time as the pressure on the trigger is being applied, so that as the aim becomes correct a final increase of pressure releases the shot. If the target is moving, the rifle is swung like a shotgun in the direction of motion and the mark is led by the amount necessary.

Rapid Fire

To become proficient at rapid fire with either single-shot or repeating rifle, or with a pistol, it is necessary to develop a rhythm so that there is an exact interval of time between shots. Some experts recommend that the shooter should practise counting or repeating a phrase, at first with the aid of a clock or metronome and afterwards as a habit. He will then release his shots steadily and unhurriedly in just the amount of time allowed in the competition.

Pistol Shooting

The principles of target shooting with pistol or revolver are basically the same as those of rifle shooting in the offhand position. In the first place, there are of course the essentials of holding, aiming and trigger squeezing, of which the first needs the most detailed description owing to the difference of form of a pistol as compared with a rifle and to the fact that it is held in one hand.

The slightest difference of hold alters the aim of a pistol by no small amount, so the hold must be exactly the same throughout the shooting of a target if a close group is to be formed. And if all groups are to be in the same position on successive targets, the hold must remain the same from target to target.

There are several positions of the hand recommended by different experts. They do not suit everybody. Each shooter needs to learn the position which suits him and the pistol he is using.

The usual position of the hand is with the thumb stretched along the side of the pistol and the first finger curled round the trigger, but also resting on the side opposite to that which is held by the

[*Photo. Messrs. Gale & Polden, Ltd.*

FIG. 83.—TARGET PISTOL SHOOTING.

thumb. The remaining fingers are placed round the grip. The back strap of the pistol rests against the ball of the hand.

The shooter stands upright half facing the target, with the right foot towards, or a little to the left of the target, the right arm at full stretch, hand, arm and pistol barrel being in very nearly one straight line. He then takes a deep breath, so as to be able to hold his breath as in rifle shooting at the moment when the shot is released.

Complete ease and relaxation are even more necessary in pistol shooting than in rifle shooting, for it is impossible to eliminate visible tremors or swaying entirely, and any state of tension increases involuntary movement. It is because of this movement that the trigger has to be squeezed just at the right moment as the sights come into line, in the same manner that a rifle is fired offhand. Great care has to be taken in squeezing the trigger straight back and not sideways, for a slight sideways pressure is certain to deflect the aim.

Firing at laterally moving objects with the pistol, while of practical utility, is ruled out of club and competition shooting because of the dangers involved. A description of methods by which proficiency may be acquired where such shooting can be practised in safe surroundings is given in the final chapter.

Spotting

When spotting for another shooter, the positions of the shots are described with reference to a clock face imagined to be superimposed on the target. Shots can then be described as follows:

Dead centre bull	All in carton
Touching the bull ring but to the right	Bull at 3 o'clock
In the 9 ring but below the bull .	Nine at 6 o'clock
Only just touching the 9 ring to the left of the bull . . .	Bad nine at 9 o'clock

and so on.

CHAPTER XXI

TARGET RIFLEMAN'S EQUIPMENT

ANYONE who takes up target-shooting seriously, inevitably acquires an outfit of ancillary equipment, the total cost of which may exceed the price of any English made target rifle.

Most juniors begin shooting with a club rifle and sling, club elbow pads, club telescope and club shooting block. The first purchases that a beginner makes are his own rifle and sling, and these may be followed by a pair of elbow pads and a shooting block *cum* magazine. But once the shooter starts to attend open meetings, a complete outfit becomes necessary.

Several accessories have to be taken to an open meeting, and as it is very annoying to have arrived at the range to find you have left something behind, it is worth while making a list on a card or on the cover of the note-book in which you will stick your competition tickets or record sight readings. The following is the list which the writer uses when small-bore shooting :

Items required for shooting at the local range.

Rifle.	Left eye shade.
Ammunition.	Sight protectors.
Shooting block.	Rifle bag.
Sling.	Shooting coat.
Shooting glove.	

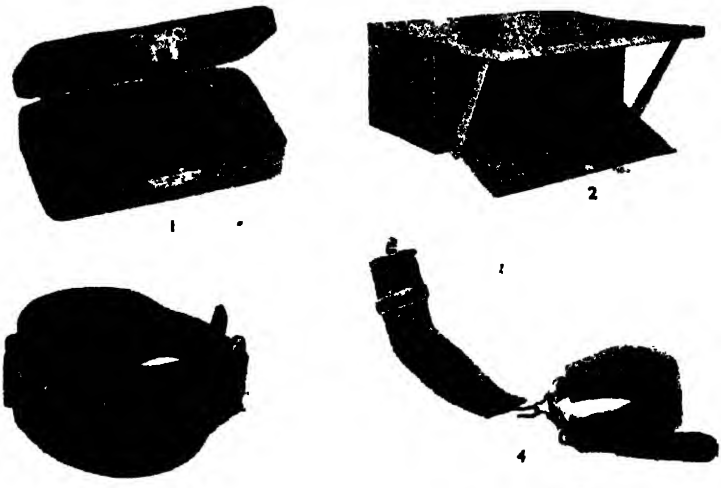
Additional items required at public meeting.

Cleaning rod with jag and brush, or pull-through.
Patches.
Oil.
Telescope.
Tripod.
Stone slip for adjusting trigger.
Note-book to hold tickets (which are to be stuck on targets).
Sight diary (see Chapter VIII).
Programme and other papers relating to the event.
Ground-sheet.
Rifle rest (to keep rifle off ground when not in use).

Cartridge Block and Magazine

For shooting at open meetings competitors must have a cartridge block made to hold exactly the number of cartridges to be fired. This usually means a block having ten holes in which ten cartridges can be placed. For practice shooting a block

Fig. 84.—Home-made Eye Shade.
(Half-size.)



[By courtesy of Messrs. Parker-Hale, Ltd.

Fig. 85.—Target Shooting Equipment.

1. Cartridge Box. 2. Shooting Case for Service Rifle Competition Shooting. 3. Ten-shot Wrist Bandolier for ·22 Long Rifle Cartridges. 4. Cuff Sling for Small-bore Target Shooting.

taking several cartridges is useful to allow for the number that may be fired at the siting card or bull. A block suitable for both purposes can easily be made.

Take a piece of hardwood 1 inch thick, mark the centres of ten holes in two rows of five on one side and bore with a ¼-inch

twist drill $\frac{5}{8}$ inch deep. On the other side mark the centres of fifteen or more holes, care being taken that none of these coincides with the holes already driven, and drill as before.

Magazines to take boxes of cartridges are obtainable with sliding lids which are drilled to serve as cartridge blocks. Alternatively, a block of wood may be drilled with sufficient holes to take fifty or more cartridges, and fitted with a hinged lid so that it may serve as a magazine, and the reverse side drilled with ten holes.

Messrs. Parker-Hale make two patterns of "quickloader", which is a cast-aluminium ten-hole cartridge block, made for fixing on the side of a Martini action. This is particularly useful in rapid-fire competitions.

Shooting Coat

Canvas shooting coats with padding for the elbows, on the upper left arm in the sling position, and on the right shoulder, and with pockets at the back, where they will not be in the way when the shooter is in the prone position, are available in various

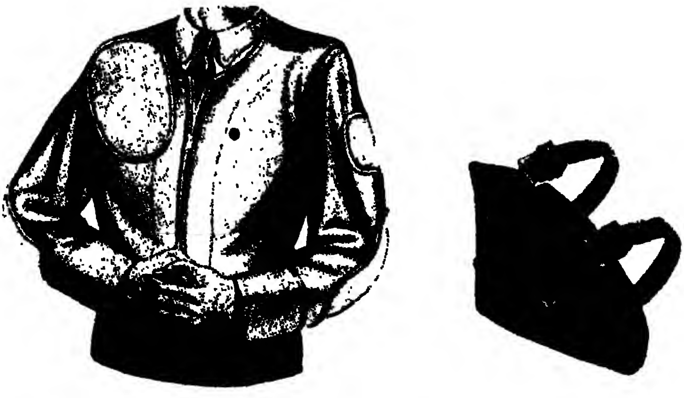


Fig. 86.—N.S.R.A. Shooting Coat. Parker-Hale Elbow Pad.

sizes from the N.S.R.A. (see Fig. 86). Left-handed coats are also available.

A shooting coat can be made from any suitable jacket by padding it in accordance with the rules of the N.R.A. and the N.S.R.A. The padding for the left arm includes a pad on the upper arm where the sling is supported, and here an Army belt-hook should be

sewn to keep the sling in position. All that is necessary for the left elbow is a small pad with a 1¼-inch hole cut in the centre to take the elbow, which, if not held in a ring, tends to slide about on the loose skin. This pad can be carefully placed in position before shooting. The padding for the right arm needs to be fairly extensive, for the right elbow does not adopt the same position relative to the sleeve every time, and a pad with a hole in it is quite impracticable. The right shoulder-pad should extend from the jacket well on to the top of the sleeve.

The positions for the pads can be found by adopting the normal shooting position with the sling and getting someone to chalk mark where the sling and the rifle-butt rest and where the left elbow touches the ground.

Padding not more than ½-inch thick may be worn on the shoulder, on the elbows (not exceeding 8 inches square) and also on the upper arm, provided the last is separated from the elbow padding. Padding must not be worn outside any military uniform. Strap-on elbow pads may be worn, but in no case may the total thickness of padding exceed ½ inch.

Spotting Telescope

The spotting telescope is an ordinary terrestrial telescope of good definition and having a power of about twenty magnifications. If the telescope is otherwise good, an object glass of 1¼ inches diameter is sufficient. The field of view should be wide enough to pick up the whole of the target, including an extra sighting card, where this is permitted. Simple telescopes of the draw-tube type serve quite satisfactorily, although focusing by rotating the eyepiece or by means of a sidescrew is a slight advantage.

To test a telescope, focus it accurately on a used target at the maximum range for which the telescope is to be used, and make sure that the bullet holes are visible not only when the bull is central, but also when the tube is moved so that the bull comes near the edge of the field, for some telescopes give a clear centre to the field, but a blurred edge. As this means re-aligning the tube to look at bulls other than the centre bull, it is a serious disadvantage.

The tripod and mounting of the telescope are important. They should not be chosen from the point of view of appearance,

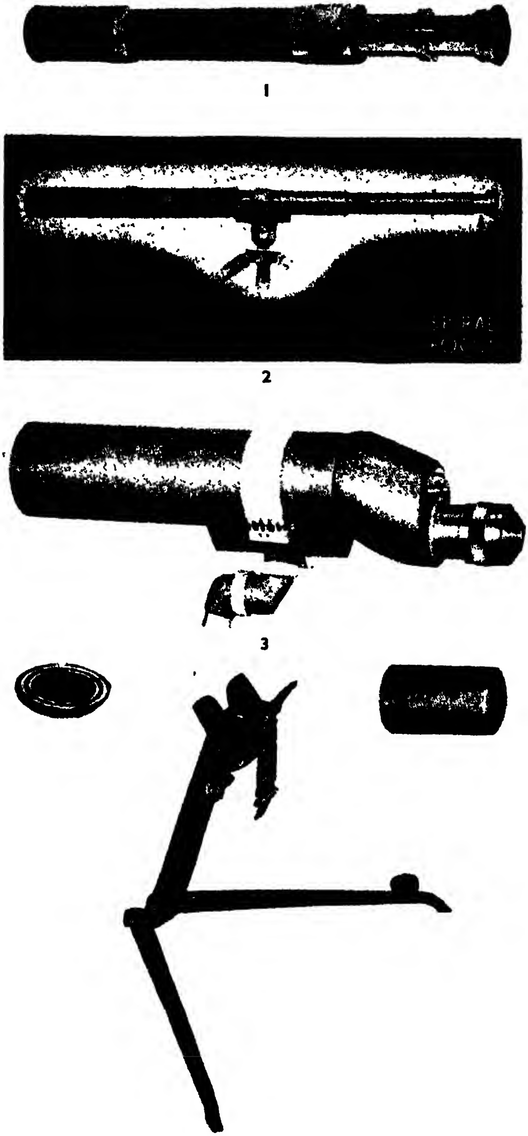


FIG. 87.—1. OTTWAY ORION SPOTTING TELESCOPE. 2. STEWARD SPOTTING TELESCOPE. 3. ROSS–PARKER-HALE SPOTTING TELESCOPE WITH DUST CAPS. 4. PARKER–HALE "CLOSE-UP" TELESCOPE STAND.

but for their practical utility. Some quite expensive tripods made specifically for the purpose of supporting spotting telescopes have the disadvantages of dithering on the slightest touch or in a wind or, of suddenly collapsing because the legs move too easily. A simple tripod should be firm and steady, and the mount at the top which holds the telescope should be neither wobbly nor, if it is here that adjustment is made, unduly stiff.

Some telescope stands are not true tripods but devices to hold the tube in such a manner that there is not a third leg which might accidentally be hit by the rifle barrel (see Fig. 87).

It is worth while making or purchasing an oilskin cover to strap over the telescope in wet weather.

Ticket Book

So as not to be flustered when finding tickets during shooting, an open-air competitor should supply himself with a hard-covered note-book into which he can stick the tickets by the end only. The rifle-sight diary will do for this purpose, for the tickets occupy only a few pages, which can be used again and again at different meetings. It is advantageous to cut thumb-holes in the note-book so that it will open at once just where wanted. These thumb-holes can be marked with the range—25 yards, 50 yards, 100 yards, etc.—also pages can be reserved for unlimited and practice tickets. Below the range, reminders of the elevation and windage can be written, and the number of clicks necessary to bring the rifle to that elevation from the 25 yards adjustment.

Score Book

When small-bore shooting, the shooter can see the group developing on the target, but on the service rifle range each successive shot hole is patched out immediately the value of the shot has been signalled, and therefore the competitor needs to keep a record to which he can refer from time to time in order that he may know just what he and his rifle are doing.

Messrs. Parker–Hale publish a " S.R.b. Service Rifle Score Book ", which includes target diagrams, elevation tables, wind calculator and other useful features; a " Loose Leaf Score Book ", with whole page diagrams on which to plot shots; and a " Rifle

Shot's Register", which contains a treatise on rifle shooting, wind reckoner with flag diagrams, elevation tables and dimensions of targets.

Shooting Case

The service rifle shooter needs a case in which he can carry his equipment in convenient order, which serves as a shooting block, and in which his score book can be kept open protected from the weather. A large range of these are available, the choice depending on the pocket of the individual. Fig. 85 illustrates a comparatively low-cost article which has been introduced in view of the very high present-day price of leather cases after the addition of purchase tax.

CHAPTER XXII

CLAY PIGEONS

THE Clay Pigeon Shooting Association, which was formed in 1893 as the Inanimate Bird Shooting Association and brought clay pigeon shooting into prominence, governs in England this increasingly popular sport. There are separate associations for Scotland and Wales. The addresses are as follows :

The Clay Pigeon Shooting Association,
276 Whitchurch Lane,
Edgware, Middlesex.

The Scottish Clay Pigeon Association,
c/o The Commercial Bank of Scotland Ltd.,
Lossiemouth,
Morayshire.

The Welsh Clay Pigeon Shooting Association,
Meiros,
Treherbert,
Glamorgan.

The official journal of the Clay Pigeon Shooting Association is the *Clay Pigeon Shooting News*, published by Gale & Polden Ltd., the Wellington Press, Aldershot, Hants. The Association issues also an *Official Handbook of Clay Pigeon Shooting*, which gives recommendations on the preparation of grounds, and includes rules for competition shooting and methods of handicapping. Advice upon club formation is also available.

In addition to the practice at the shooting school, described in Chapter XIV, there are two recognised forms of clay pigeon shooting : trap (or down-the-line) and skeet. The former is a highly competitive pastime which, because the methods adopted for success in competition differ from those applicable to game shooting, is sometimes considered to conflict with successful shooting of game. This is probably true when, as is usual, the rules permit the gun to be held in the " gun up " position. But if the gun is kept at " gun down "—*i.e.* stock below armpit—until

the bird is released, trap shooting can be useful practice for the game shot. Skeet also is a competitive game, but in view of the variety of shots it affords and a rule that guns must be held at gun down, it is excellent practice for the shooting-field.

Down-the-line

A flat, open field is selected, and the trap is set to throw the clay pigeon to the north-east away from the shooters, so that sun-glare will not interfere with shooting. A distance of 300 yards from the trap in all directions in which the gun is fired is considered a danger zone, and due precautions should be taken—*e.g.* when setting up the club, by purchasing and enclosing the amount of land necessary.

The shooters, usually a squad of five, stand at the firing points, which are spaced 3 yards apart on the arc of a circle of 16 yards radius, at the centre of which is the trap. The trap is installed in the traphouse, a low shed with an earth bank which protects the "trapper" who feeds the mechanism with clay pigeons. The pigeons are released by the "puller", whose position is at the pull-stand 7 yards behind the firing marks.

The "auto-angle trap" (see Fig. 89) is now the standard equipment for club and competition shooting, because it automatically throws clay birds at angles which cannot be predicted, and thus has virtually replaced the "Sergeant" system, which necessitated the use of three "single" traps spaced 4 feet apart.

The trap is adjusted to throw the birds a distance of not less than 45, or more than 55 yards, and to a height of 6 to 12 feet at a point 10 yards from the trap. Except in double pigeon shooting, the targets should be thrown at unpredictable angles within an area bounded by angles of 45° left and right of a straight line drawn through the pull-stand, No. 3 firing point and the trap.

The shooters take their positions with their guns open and in the position gun up or gun down, as may be permitted in the competition. The first shooter (numbering from the left) loads with two cartridges and calls "Pull", on which the puller releases a target. If the shooter fails to "kill" with his first barrel, he may shoot with the second. The result is recorded by the referee. The same procedure is followed for the remaining members of the squad in turn, until a pre-determined number of

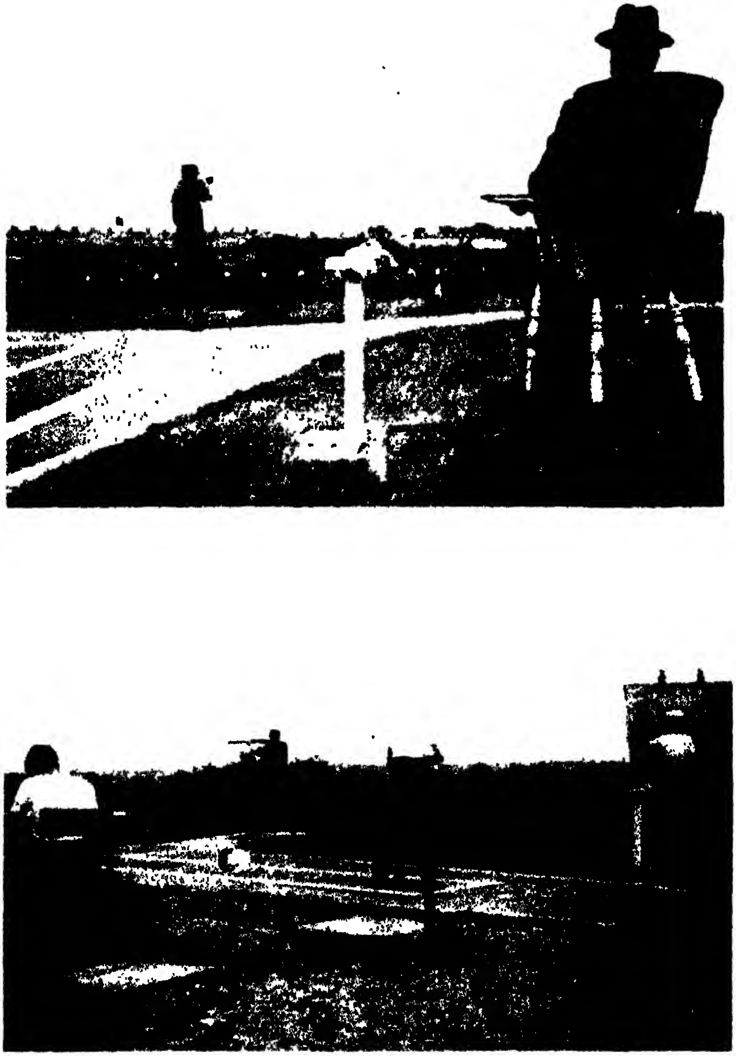
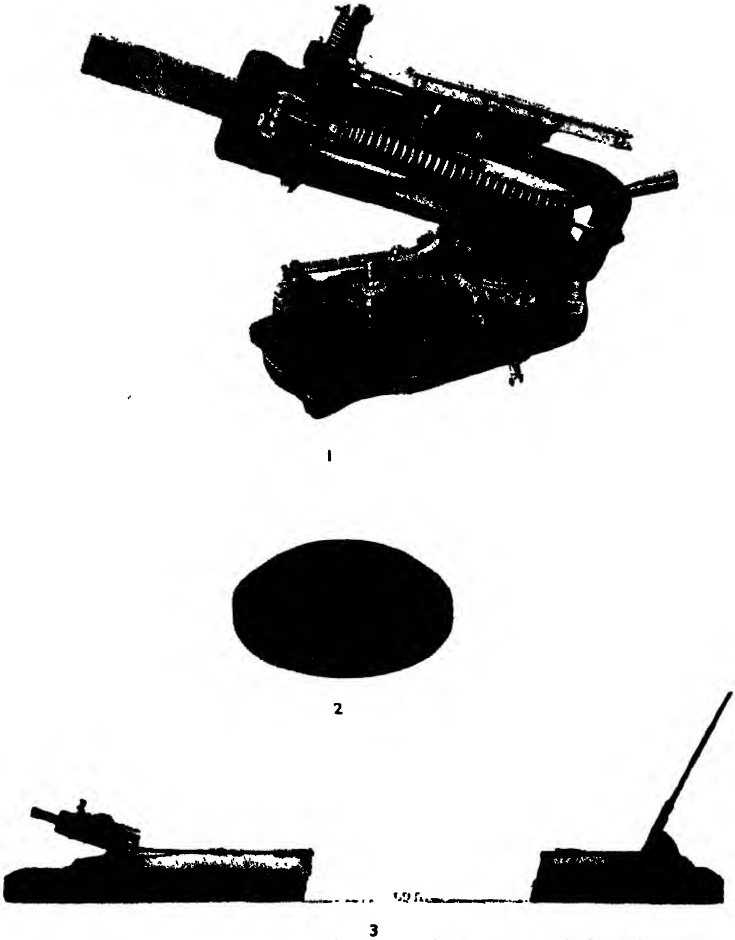


Fig. 88.—Trap Shooting at the Bisley Gun Club during the N.R.A. Meeting.



[*By courtesy of Messrs. Imperial Chemical Industries, Ltd.*

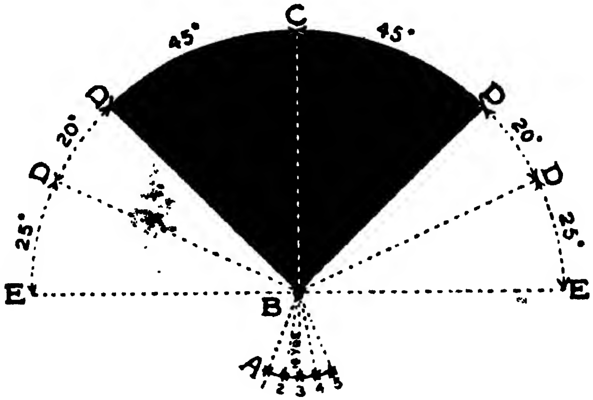
FIG. 89.—1. AUTOMATIC ANGLE TRAP. 2. CLAY BIRD. 3. ARRANGEMENT OF AUTOMATIC ANGLE TRAP AND OPERATING LEVER.

The automatic angle trap is the recognised standard equipment for down-the-line shooting in club and competition work. Birds are thrown at an angle which cannot be predetermined by puller, trapper or shooter. The trap can easily be converted to throw "double rise".

targets has been shot. Then the shooters move one point to the right, except the fifth, who adopts position No. 1. In this manner shooting continues until all members of the squad have shot in all positions (see Figs 90 and 91).

SKEET

Skeet was introduced in America in the early 1920's, and came to England about ten years later, since when it has achieved great popularity because it provides between-season practice and recreation for the game shot, and in this respect contrasts with

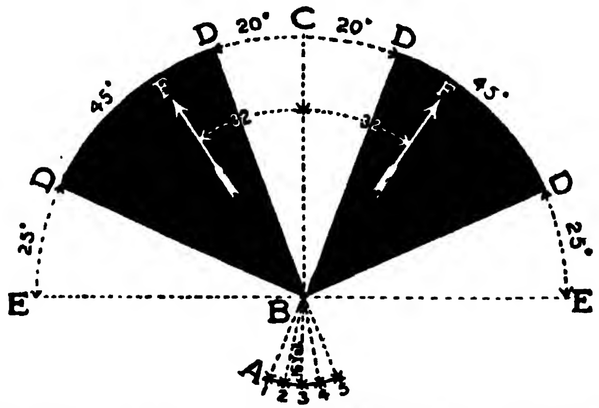


This illustration is taken from the Clay Pigeon Shooting Association's Official Handbook, where acknowledgment is made to Imperial Chemical Industries, Ltd., for permission to reproduce.

FIG. 90.—SINGLE PIGEON SHOOTING, SHOWING FIRING POINTS AT *A*, TRAP AT *B* AND, IN BLACK, AREA IN WHICH PIGEONS ARE THROWN IN SINGLE PIGEON SHOOTING.

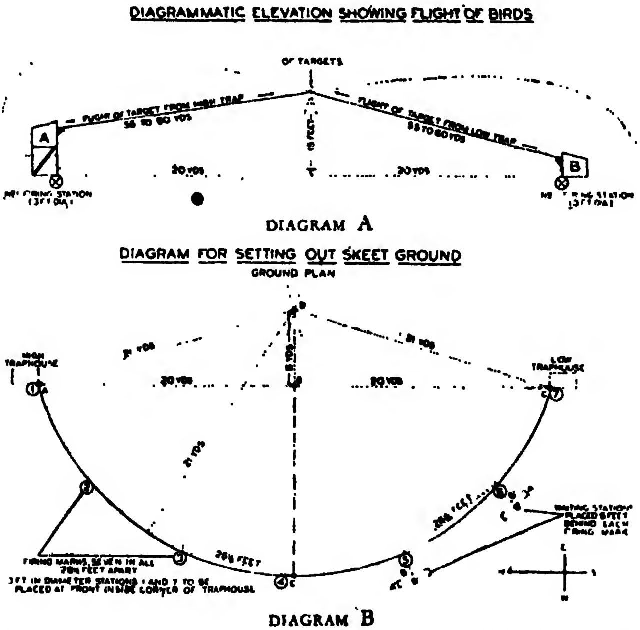
down-the-line, for which special guns are often used and in which it is common to have gun up. At skeet the rule is gun down, and a shooter may not " call for " or " address " his bird.

The skeet ground is laid out with two traps, 40 yards apart, and set to throw single birds at an angle so as to cross each other's path at a point midway between the traps and 6 yards beyond a straight line drawn from one trap to the other. At this point the targets should have attained a height of 15 feet. The trap to the left of the shooter is known as the " A " trap, and is arranged 10 feet above ground level. The " B " trap on the right is raised 3 feet. If practicable, the " A " trap should be due



[*This illustration is taken from the Clay Pigeon Shooting Association's Official Handbook, where acknowledgment is made to Imperial Chemical Industries, Ltd., for permission to reproduce.*

FIG. 91.—DOUBLE PIGEON SHOOTING, SHOWING FIRING POINTS AT *A*, TRAP AT *B* AND, IN BLACK, AREAS IN WHICH PIGEONS ARE THROWN IN DOUBLE PIGEON SHOOTING.



[*This illustration is taken from the Clay Pigeon Shooting Association's Official Handbook, where acknowledgment is made to Imperial Chemical Industries, Ltd., for permission to reproduce.*

FIG. 92.—LAY-OUT OF SKEET GROUND.

north of the "B" trap, in order that sun-glare shall not interfere with shooting.

There are seven firing points equally spaced on the arc of a circle of 21 yards radius, the centre of which is the point where the lines of flight of the targets cross. The first station is beside "A" trap, the seventh by "B" trap (see Fig. 92). The first shooter stands in No. 1 position, loads his gun with one cartridge only and holds it at gun down. Within three seconds of position being assumed, the referee signals (by push-button and electric lamp or some other means which the shooter cannot detect) for a bird to be released from the "A" trap. As soon as the first shot has been fired, the shooter reloads and receives the bird from the "B" trap, after which he opens his gun and vacates his place, which is taken by the remainder of the squad in turn. Single shots are taken in this manner from all the seven firing-points. Thus, each of the shooters has to deal with birds retreating or approaching at a variety of angles.

The single shooting is followed by the doubles, which are fired from stations 6, 4 and 2 (in that order), but not the end stations, 1 and 7. Now the shooter fires at the bird from the "A" trap, and on the report of his gun a second bird is released from the "B" trap, making him swing sharply to pick it up.

A new shooting game involving a trap and target devised by Major H. R. Northover, O.B.E., M.C., was introduced at a tournament held at the Bisley Gun Club on 3rd September, 1950. The competitors were squadded in fives in a similar manner as in down-the-line, but 18 yards from a track 50 yards long having a trap at each end and a "blind" half-way. Shooting was according to provisional rules drawn up for the meeting.

According to these rules, five drives are shot. In drive No. 1—"running skuts"—the squad stands with guns loaded but open and in the gun down position. When No. 1 closes his gun, the "skut" target is released (being secretly signalled as in skeet) to run as a rabbit along the track. When No. 1 fires, No. 2 closes his gun and a skut is released from the opposite trap, and so the shooting continues, until every member of the squad has fired at two targets, one released from each end of the track. Then they change position as in down-the-line.

In the second drive the traps are adjusted to throw targets into the air, otherwise the procedure is as before. In drives three and four both ground and bird shots are taken in various combinations of doubles, and the fifth drive is confined to " birds " only. As in skeet, the second target of a double is released on the report of the competitor's gun.

At the time of writing, the traps for this new game are not yet on the market, and it is likely to be some time before they are available to the general public.

CHAPTER XXIII

FIREARMS AND FICTION

To add excitement to their stories many writers of fiction forsake every day experience, and take violence, crime and criminal detection for their theme, or else depict life in wild, remote places where law and justice do not run. In such imaginative exercises, firearms, as the effective instruments of sudden death and the accoutrements alike of pursuer and pursued, find a prominent place, and are brought into play with as little concern as one might resort to the ordinary tools of industry. But it is often clear that the writers either have no experience in the handling of lethal weapons or if they have used the rifle or shotgun in sport, or the rifle and other firearms in war, that outside this experience their knowledge is very limited. It is not surprising therefore, should we quite commonly detect gross errors regarding the use of firearms by desperadoes and law officers in the stories spun for us by the less careful amongst this class of writer.

There are many writers who are very careful of their facts and delight in acquiring out-of-the-way knowledge, but others are less scrupulous, knowing that even if their errors may amuse or irritate the critical, most readers will pass them over.

The following material is not written just to deride the technical errors that authors frequently make, but to give in outline those sections of the study of small-arms and ballistics which should be of particular interest to writers, but which have not been covered in the foregoing chapters.

Sources of the Criminal's Armoury

The criminals of fiction have the latest equipment and are lavishly supplied with arms and ammunition. If the gang are disarmed one day, they turn up with fresh accoutrement the next. But real-life criminals have to take what they can get, although there must be no small number of Sten guns in illicit circulation, and also many rifles and pistols, as can be judged by the large quantities of arms and ammunition that are annually surrendered

[All the above are reproduced from a pre-war Jeffery catalogue

FIG. 93.

1. Mauser Self-loading Pistol with Wooden Holster which also Attaches to Serve as a Butt Stock. 2. Browning Self-loading Pistol. 3. Colt Self-loading Pistol. 4. Webley Self-loading Pistol. 5. Smith and Wesson Target Pistol. 6. Colt Revolver. 7. Harrington and Richardson Revolver. 8. Parker–Hale Sound Moderator. 9. Greener Humane Cattle Killer. 10. Webley and Scott Humane Killer. 11. Harrington and Richardson Revolver, Broken down for Unloading.

The Colt revolver cylinder swings out sideways to load. The Harrington and Richardson breaks to load, ejecting its cartridges, as does also the modern Webley and Scott.

to the police. It is safe to assume that these arms include weapons of all dates, types and countries of origin.

Many of these illicit weapons were acquired during war, purchased from people off ships, manufactured from so-called toy pistols, or stolen during entry to premises. These are secreted until their owners get tired of them or find someone who is prepared to offer an attractive price. Thus in due time they find their way to the underworld.

But ammunition presents the criminal with a real problem. For pistols stolen or bought are usually accompanied by very small stocks, often no more than the contents of the magazine or cylinder; and while the weapons themselves remain in circulation, ammunition is depleted as each successive owner is tempted to fire a round or two to see if the gun works. The police are only too well aware of this fact, which is one of the main reasons why they do not like large stocks of ammunition to be held by respectable citizens without good reason or unless it is evident that ample safeguards will be taken against theft.

The shortage of ammunition in the underworld is so great that criminals having weapons are prepared to go to great pains in converting cartridges to uses for which they were not intended. For example, it has been known for the rims of flanged cartridges to be filed off to permit them to enter the chamber of a self-loading pistol.

Pistols

As will have been gathered from the brief mention of pistols in Chapter X, pistols are not all alike in the way they work or can be used. The fiction writer recognizes two main types, the revolver and the semi-automatic, which are in fact most handy weapons for dangerous criminals and most likely to be used. These are often mentioned by name, as if the reader knew as well as the author what the different kinds are, but soon the author adds something which shows that he or she does not know what the weapons are like or how they function, or does not appreciate how difficult they may be to handle or how few people can handle them properly.

Let us take first the semi-automatic or self-loading pistol. This is always described as an "automatic", and here the writers, while not strictly correct, are advised to keep to the popular term,

though the more correct expression would be "self-loading" pistol. Everybody knows what is meant by "automatic pistol", and even gun-makers' catalogues and some books on firearms use the expression. But now the distinction is that an "automatic weapon" is one which continues to fire for as long as the trigger is held, while a self-loading weapon is one which loads itself and fires one shot every time the trigger is pressed. In the latter class are pistols such as the Webley & Scott, Luger or Parabellum, Browning, Smith and Wesson, Harrington and Richardson, Colt, etc., some of which are illustrated in Fig. 93. Such may be acquired by civilians having suitably endorsed firearm certificates. Among automatic weapons are the Sten gun, the Thompson sub-machine gun, the Bren gun, etc. These cannot be obtained on a firearm certificate: they are classed as "Prohibited weapons", and may be held only on the authority of the Admiralty, the Army Council or the Air Council, to whom application must be made when they are needed for theatrical or film purposes. Under the head of prohibited weapons come also pistols or ammunition designed or adapted to contain or discharge any noxious liquid, gas or other substance.

A not uncommon error is to believe that the ordinary self-loading "automatic" pistols do go on firing for as long as the trigger is held. It so happens that such a truly automatic pistol does exist, but it is understood that there is only one make of this kind, the 1932 model Mauser.

Sometimes the term "automatic revolver" is used and when this is found it can generally be assumed that the writer is merely confusing terms. Again, however, there is one exception in the Webley-Fosbery ·455 automatic revolver which, in general design, resembles the ·455 Webley Mark VI, but differs from any other revolver in that the recoil cocks the hammer and rotates the cylinder after each shot.

The pistols used in detective stories seldom go wrong, and, however inexpertly used, do not miss the mark, unless a hit would be inconvenient for the purpose of the story. Actually, self-loading pistols are not altogether infallible: a pistol can mal-function and let the shooter down at an awkward moment. How many times does the amateur detective shoot with his automatic from the pocket? If he did so, he would no doubt get away the first shot; but a self-loading pistol, when fired from the

pocket, almost certainly jams and refuses to go on firing. Incidentally, most of these pistols if fired from the hip are liable to eject their cartridges very forcibly in the shooter's face. The writers would therefore be advised to stick to revolvers when describing shooting from the pocket or the hip.

Very frequently the crook or detective, as the case may be, is described as ramming the muzzle of his gun into the back or ribs of the man he is trying to guard, just to let him know that it is there. This is all right if he is using a revolver, but pushing on the muzzle of a self-loading pistol of the recoil operated type pushes back the slide, in which position the pistol cannot be fired.

Then there is the matter of "safety catches". Self-loading pistols almost invariably have thumb-operated safeties, which are necessary because self-loading pistols, to be immediately available, must be ready cocked and therefore would be dangerous if there were not a safety to prevent accidental discharge in the pocket. On the other hand, a revolver is far from easy to discharge accidentally and therefore a safety of the thumb-operated type is not necessary and not usually provided.

Revolvers, while (as mentioned in Chapter X) they vary in important details, are all very much alike in general appearance, and have not greatly differed in this respect for a very long time: there were revolvers more than noticeably similar to present-day patterns before the invention of fixed round cartridges.

As to the effectiveness of pistols, the following points may be of interest. The ·455 service revolver has an extreme range which is slightly more than that of a ·22 rifle. It is also effective as a weapon up to 300 yards – a much longer distance than is generally appreciated. It is of quite good mechanical accuracy. Nevertheless, a revolver is essentially a weapon for quick use at close quarters, for owing to the short sight base and the limitations of a one-handed weapon, the personal factor reduces its effective range to about 75 yards.

There are some special weapons of little interest to the average rifleman, but which could give ideas to writers. For example, there is the humane cattle-killer illustrated at the foot of Fig. 93. In the Sherlock Holmes stories a murder is done with a whale harpoon. In these days harpoons are fired from guns, including a Martini-action shoulder gun made by Greener.

Anachronisms are very liable to creep into historical novels even when, presumably, the writer knows the facts : it is all too easy to forget the exact date of evolution of every invention at the period in which the story is set. Errors can be avoided by care and checking against specialist works. For knowledge of old-time firearms, reference should be made to collector's books such as *A History of Firearms*, by H. B. C. Pollard; *English Guns and Rifles* and *English Pistols and Revolvers*, both by J. N. George; *British Pistols and Guns, 1640-1840*, by Ian Glendenning; and *The Rifle in America*, by Philip B. Sharpe, which, although in a different category, covers the history of American firearms in considerable detail.

Noise

Gun noises are strange in their variety. The amateur detective hears a shot and knows at once what it is : he does not mistake it for the after-fire of a motor car. On the other hand, the writer's wife hearing a rifle shot went to the front door to see who had knocked. And she has heard a lot of shooting !

Long-barrelled rifles of ·22 calibre make perhaps less noise than any other firearm, because the energy of the small explosion is largely taken up by the bullet, and pressure is much reduced before the gases escape at the muzzle. A ·22 rifle fired indoors seems quite noisy, but not excessively so : on the open-air range or any open plain it only spits, but if let off in a valley and hilly country it echoes round the hills surprisingly. If high-velocity ammunition is used the noise is considerably increased, because as soon as the speed of sound is exceeded the crack of the bullet passing through the air is heard as well as the muzzle blast; and if the rifle is shortened by cutting some inches off the end, there is a very noticeable increase of muzzle blast.

When shooting at short range the sound of the bullet striking the target is not heard unless the noise of the rifle is reduced by stopping the ears. At 50 yards or more the strike of the bullet is always audible and very noticeable. If a ·22 rifle is fired into water (with of course due precautions against causing injury by ricochet), the smack as the bullet hits the water sounds louder to the shooter than the explosion of the cartridge.

Larger-calibre rifles and shotguns sound much louder and heavier than ·22 rifles. But to the shooter himself a large-

calibre pistol seems the loudest, even to the extent of being disconcerting or painful to the ears because, owing to the short barrel and comparatively large charge, the muzzle blast is very great. Protection of the ears is, in fact, recommended for heavy pistol target shooting.

The hero of one series of novels silences his shots by reducing the charge in his cartridges. This would not have much effect. Another writer relates how a criminal made a blank cartridge by pulling the bullet out of a live round and firing the remaining charge so as to alarm the household. This would not work, for without the pressure exerted by the bullet the percussion cap would explode with a minute crack like that of a toy cap pistol, blowing out the charge of powder without igniting it.

Silencers

This brings us to the matter of silencers, another class of apparatus which is more familiar in fiction than in real life. Time and time again one reads about the crook who fits a silencer to his pistol, which he then fires without attracting anyone's attention.

One type of silencer is a cylinder which screws on to the muzzle of the weapon and consists of two parts : an expansion chamber which absorbs the explosion of the gases, and a series of baffle-plates which let the gases escape slowly after the bullet has gone. The bullet passes with a small annular clearance through holes in these plates.

Silencers *can* be very effective in the right circumstances. A ·22 rifle fitted with the Parker–Hale sound moderator illustrated in Fig. 93 makes about as much noise as an air-gun and a very similar sound, provided that standard, low-velocity ammunition is used. But it would be a very different matter to attempt to silence a ·22 rifle chambered for one of the American high-velocity cartridges such as the Swift.

Seeing that pistols are particularly noisy, they are difficult to silence, and a silencer, to be reasonably effective, becomes unduly large and ponderous, spoiling the balance of the weapon. Even then it may only take the edge off the crack, without very noticeably reducing it. Revolvers are more problematical than pistols, for even if they could be effectively silenced at the muzzle, nothing can be done to reduce the noise of the gas which escapes between

the chamber and the barrel. For this reason a writer should never refer to a silenced revolver.

In one respect pistols are easier to silence than rifles : generally the velocity of the bullet is below that of sound, and therefore no bullet-crack has to be taken into account.

A silencer exerts a pull on the barrel of a weapon, counteracting the recoil and, incidentally, altering the zero, so that if a rifle is sighted for use with a silencer it needs to be re-sighted before it can be used without. Because of this pull, the silencer must be *screwed* on to the weapon, on the muzzle of which a thread is turned to receive it. It is not just pushed on, as some writers suggest, for if it were it would blow off and cause a pistol to recoil violently.

Marksmanship

The detectives and other heroes of fiction are all marvellous shots, shooting in an emergency from the hip or through the pocket, and quite frequently hitting small marks, such as a pistol held in the hand of the villain. The crooks are sometimes equally expert, and even the wandering females, good or bad, that get picked up in the course of the story know-how to use their weapons with effect. One wonders when they can get the time to practise or find localities where trick shooting can be learnt in safety.

All pistols, in particular revolvers, are very difficult to use. Anyone shooting with them for the first time is more likely to miss a large mark than to hit it. Seeing that so little ammunition is available to the average criminal, it follows that he has not much opportunity of becoming proficient. Moreover, the shortage of ammunition also means that the ammunition which he does use is likely to be deteriorated with age and to cause inefficient functioning of a self-loading weapon.

Shooting from the hip is taught and practised, although not by the average marksman. This is actually shooting from the level of the elbow, and can be developed by practice in the following manner. A number of targets of large size are placed at a distance of about 15 feet and shots fired with the wrist resting against the body. The positions of the shots are spotted and aim corrected by moving the body as a whole, not by moving the wrist or hand independently. Lateral correction is made by a movement

of the left foot, and elevation by leaning forwards or backwards, the gun being held firmly against the body when it feels right in the hand. In the first stages of practice the gun is lined up visually with the target and the trigger carefully squeezed until the shot is fired. If this proves a miss, the gun is moved by body-movement to correct the aim and fired again until a hit is scored on the first target. Then the shooter goes on to the next target and repeats the process.

This practice should be continued at short range at large targets until sure hits are secured, after which the range can be increased. Another form of good practice is to attempt to space bullet holes 6 inches apart on large sheets of paper horizontally and vertically. The secret of shooting from the hip is never to move the hand independently of the body. Shooting from the hip has been taught also by means of a special pistol containing an electric torch which showed, by a spot of light, where the shots would have gone.

Quick-draw and hip-shooting are seldom successfully performed other than at short range, being obviously limited by the fact that the aim is not accurately sighted, but made by the *feel* of the gun. This feel, however, does make possible a quite remarkable degree of accuracy in the hands of experts.

To shoot for accurate grouping is at first more important than hitting the mark. Then, by movement of the foot and the body, aim can be corrected. Body balance is of importance. The position should be natural and in no way strained.

Another form of spectacular pistol shooting is at objects thrown into the air. This always makes a good spectacle and good reading. The method adopted in hitting such a target is to bring the gun up until the sights come into line with the bottom of the target: then the body is bent forward so as to carry the gun down as the object falls.

In *Ed. McGivern's Book on Fast and Fancy Revolver Shooting and Police Training*, that author describes his method of putting five or six shots from a revolver into a can thrown into the air. As soon as the can begins to fall he shoots at the lower part of it, and each succeeding shot is aimed slightly lower in relation to the target. until at the sixth the gun is pointed 2 inches below it.

When shooting at a moving target, the shooter should not swing the arm, but swing the whole body from the hips, and

continue to swing through after the shot has gone. The shoulder-joint does not give so smooth a swing as can be made from the hips, and also necessitates that the head shall be turned to maintain line with the sights.

Shooting at small targets in the air is helped, like ordinary shooting on the range, by the fact that a dead-centre hit is not necessary. The actual size of the group necessary to ensure a hit is a ring having a diameter equal to that of the target plus the bullet.

Shooting Indoors

Many of the shots fired in fiction are let off indoors, but never do we read of the shooter being hit by his own bullet. The writer has never risked using firearms within walls except at a suitable bullet trap, but he has often used an air-pistol in a space enclosed by brick walls, and time and time again has been hit by the harmless ricochet. This is a point that fiction-writers might keep in mind: if a shot is fired towards the corner of a room it is almost certain to ricochet from one wall to the other, returning towards the shooter, with every chance of injuring him.

Forensic Ballistics

We now come to the subject which should be of most particular interest to the writer of detective fiction. It is the study which involves the actual methods used in crime detection where firearms have been employed.

When a fatality has been caused by a firearm, it may be necessary to prove, by expert examination of the wound, the ammunition, the weapon and surrounding objects, whether the death was the result of an accident, suicide or murder. Should murder be suspected, a firearms expert would have to assist the police in identifying the type of weapon used, by examination of a bullet or discarded cartridge case found on the scene of the crime; and perhaps ascertain that this bullet or cartridge case had, in fact, been fired in a weapon found in the possession of the suspected murderer.

Such investigations require of the expert exceptionally wide experience of firearms and elaborate techniques, for at a murder trial it is necessary not merely to express expert opinion whether or not a particular bullet or cartridge was most probably

fired in a particular weapon, but to prove to a non-technical jury that it was or was not fired in that weapon and no other.

Forensic ballistics is a very wide subject, to which textbooks have been devoted. This section attempts to give in outline only, and from the point of view of general interest, the methods of investigation used.

If you take a handful of fired cases from the club bin and examine each case carefully, you will find a number of resemblances and differences. In the first place, all cartridges at a small-bore range will be of one calibre, although the trade marks of several makes will be found on their bases. But the following obvious differences will be easily observed :

1. The position of the imprint of the striker will vary from the extreme edge of the rim to somewhat nearer the centre.

2. The size and shape of the striker imprint will vary.

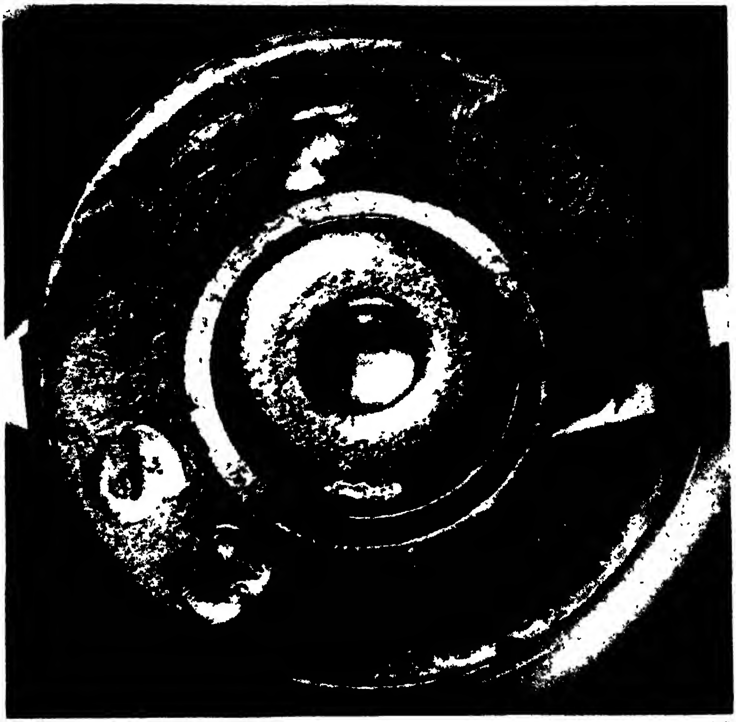
3. Cases fired in Martini action rifles will have the mark of the extractor on the side. This will vary according to the condition of the rifle from a slight oblong scratch extending half-way round to a noticeable bulge. Cases fired in bolt action rifles will not have this mark.

If you examine a fired case under a powerful lens or microscope, you will find scratches on the sides, due to roughness of the chamber, and you will observe that these are the same for cartridges fired from the same rifle, but different when the cartridges are fired from different rifles. If you measure a fired cartridge, you will find that its diameter varies according to the size of the chamber in which it was fired. So the firearm expert, by examination, can make certain if a case was used in any particular firearm.

Of great importance in the identification of arms in which a case has been fired are the impressions on the base. When a cartridge is fired, the pressure of the explosion forces its base against the breech face and, as brass and copper are softer than steel, the tool-marks and other individual dents or scratches on the breech face are pressed into the base of the cartridge, or, more particularly, on the percussion cap of a central fire cartridge. This impression varies with the pressure produced by the explosion, and therefore the markings may differ in degree from one cartridge to another fired in the same weapon; but the pattern will be the

same, in so far as it is produced by the pattern of the tool marks, scratches and indentations on the breech face.

An estimate of pressure produced by a cartridge can be made by inspection of the fired case. High pressure expands the case, producing the impression of the extractor on a shotgun cartridge. High pressure also crushes the primer against the breech face,



(By courtesy of The Forensic Science Laboratory, Cardiff.

FIG. 94.—PHOTOMICROGRAPH OF HEAD OF A FIRED CARTRIDGE.

flattening it out, whereas low pressure leaves it rounded at its outer edges more or less as it was before firing.

Accidental scratches or dents in the action face appear in relief on the base of the cartridge, and therefore may be distinguished from similar accidental blemishes which the cartridge itself has received before or after firing.

Some indica... always a danger of two different weapons producing

similar markings, which may be mistaken for individual characteristics. For example, it is not uncommon for a striking-pin to have a minute projection on the end, which is produced during manufacture. There are also similarities of tool marks which occur on mass-produced weapons. These accidental "family" similarities have to be distinguished from true individual peculiarities.

The extractor of a bolt action leaves its mark on the edge of the rim, and can be seen when the cartridge is viewed from the base. The mark it leaves may be very slight indeed, and indistinguishable from accidental scratches unless the extractor fits closely. The ejector of a breech action also leaves a mark which can be very pronounced on a case fired in a self-loading pistol, owing to the violence with which such a case is ejected. The impression varies with the pressure developed by each cartridge.

Extractor and ejector marks are particularly useful in making it certain which way up a centre fire cartridge was when fired, for when cartridges are being compared they must, of course, all be placed exactly the same way up.

Identification of Bullets

Rifled barrels differ in calibre, in the number, width, shape and depth of the grooves, and direction of twist, and these characteristics can be found on a bullet which has been fired through the barrel, provided that it is not damaged beyond recognition. The lands produce comparatively deep furrows, which can be seen without the aid of a lens. Between the lands are microscopic scratches which are the tool marks made during rifling, together with more recent striations produced during the use of the weapon. These finer striations change rapidly and the "engraving" of the inside of a barrel may be completely changed by as few as twenty-five rounds of jacketed bullets or fifty rounds of lead bullets. This means that identification of bullets by minor striations is not possible if more than a few rounds are fired after the "crime bullet".

Bullets fired from self-loading pistols and revolvers frequently are not in line with the barrel when they enter the lands, but are subsequently forced into line. This, which has the effect of doubling the land mark, is of [illegible] he

point of view of firearm identification, but should be recognised for what it is.

For comparison with a crime bullet, two or three test bullets are fired through the weapon in question into a long box containing cotton waste or oiled sawdust. These materials have the property of stopping lead bullets without deforming them. Jacketed bullets can be stopped by firing into a depth of water.

Comparison Microscope

The comparison microscope is used for making direct comparisons of the markings on either fired cases or fired bullets, but it is much more useful for examining bullets than cases. This instrument consists of two identical microscopes mounted side by side in one frame. They can be used separately for comparing one bullet or case with another; but the instrument gained its name from the special eye-piece which links the two microscopes together in such a manner that the circular field is made up of the left half of the left field and the right half of the right field. Thus, if two bullets are placed under the two microscopes and carefully adjusted for position, "one bullet" made up of the halves of the two bullets can be seen through the special eye-piece. Then if one bullet is rotated and has identical markings to the other, at some point in its rotation the markings of the two "halves" will coincide. Complete agreement of the striations all round can be observed by rotating the two bullets by equal amounts stage by stage through a complete revolution.

There is a danger of bullets fired from different pistols being similarly marked in other than microscopic striations, because in one method of mass production barrels are made in pairs cut from single lengths of rifled tube. This has to be kept in mind.

Determining Distance from which the Shot was Fired

It is often necessary in cases where suicide might have been the cause of death to determine the exact distance from which the shot was fired. This is frequently mentioned in fiction, and in some instances the detective discovers more than could actually have been discovered in a real-life incident.

Some indications of distance are obvious, such as scorching at

very close range, or powder marking. The distance at which scorching occurs depends on the kind of powder, the size of the charge, the pressure developed and consequent completeness of combustion, the nature of the surface of the target, and whether or not it is wet. Blackening with the burnt powder is similarly affected by quantity and type of powder and the pressure developed, but not so much by wetness of the surface. Scorching usually means a very close shot of up to 3 inches with a pistol, or 6 inches with a rifle. Blackening can be caused by a pistol up to 6 inches, or 9 inches with a rifle.

Pistols, being short-barrelled and not developing high pressures, are more likely than other weapons to eject unburnt powder grains. The distance to which these could have been projected against a target can be found by careful scientific experiment with cartridges truly similar to the crime cartridge in type and actual behaviour; for example, they must produce the same pressure as condition of the crime cartridge-case suggests that it produced. In this type of test all precautions against error must be taken. It is not enough to use other cartridges of similar make or calibre—they must be identical.

Beyond the range to which unburnt powder grains can be projected it is not possible to make any accurate determination of the distance from which a pistol or rifle bullet has been fired. The difference of velocity at 10 and 20 yards is almost negligible, and could not be told from inspection of a wound. On the other hand, the distance from which a shotgun has been fired can be accurately determined from the spread of the shot and the size of the hole produced in a body at short range. To determine range it is, however, necessary to use a cartridge from the same batch as the crime cartridge and by examination of the fired crime cartridge ascertain that it was normal. If a test cartridge, proved to be in every way similar to the crime cartridge, is fired from the same gun as the fired cartridge at targets of leather stretched over a frame, the size of the hole or spread of the shot will be the same as that on the body when the gun is fired at the range at which the crime was committed. But if a different cartridge is used, producing a different pressure, or a different gun is used, the spread of the shot may be very different. No test which does not reproduce the conditions of the crime is of any value.

When the Shot was Fired

It is not possible to determine by inspection of a fouled gun or fired cartridge-case the exact time at which the gun or case was fired. The only indication of time of firing is corrosion, if any, caused by the cap composition. The rate at which this may proceed can vary in the extreme, being dependent on the composition of the products of combustion, the humidity of the air, and the metal of the barrel.

Forensic ballistics is treated by Sir Gerald Burrard in *The Identification of Firearms and Forensic Ballistics*, a new edition of which has been published recently, and by J. D. and C. O. Gunther in *The Identification of Firearms*.

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